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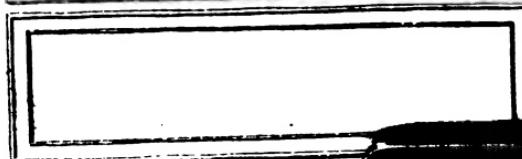
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NEW
EDITION
REVISED
GRAMMAR SCHOOL
ARITHMETIC

BY

JOHN H. WALSH

ASSOCIATE SUPERINTENDENT OF SCHOOLS, THE CITY
OF NEW YORK

BOSTON, U.S.A.
D. C. HEATH & CO., PUBLISHERS
1905

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Education Dept

INTRODUCTION.

THE New Grammar School Arithmetic forms with the New Primary Arithmetic a complete course in elementary school mathematics.

Each of the first four chapters of the New Grammar School Arithmetic provides for a half year, beginning with advanced matter, which is followed by a review and an extension of the topics of the preceding grades. Each of the next two chapters (V and VI) contains arithmetic work for a year, which should be supplemented by portions of the algebraic and geometrical material of Chapters VII and VIII. It is recommended that at least a portion of the work in equations of Chapter VII should precede the study of Chapter V.

Among the special features of the New Grammar School Arithmetic are the number and the variety of the problems; the systematic reviews, which cover oral and written drill work even in the fundamental operations; the attention paid to short, direct, business methods of computation; and the spiral handling of the various topics.



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SUGGESTIONS TO TEACHERS.

Additions and Omissions.—The teacher should freely supplement the work of the text-book when it is found necessary to do so ; and the pupils should not be required to continue the work under any topic after they fully understand it, even though they may not have solved all the problems given in connection therewith.

Oral and Written Work.—The heading “Written Problems” is merely a general direction, and it should be disregarded by the teacher when the pupils are able to do the work “mentally.” The use of the pencil should be required only so far as it may be necessary. It is a pedagogical mistake to insist that the brighter pupils of a class should set down a number of figures that they do not need. As an occasional exercise, the pupils may be directed to give all the work required to solve a problem, and to make a written explanation of each step in the solution ; but it should be the teacher’s aim to have the majority of the examples done with as great rapidity as is consistent with absolute correctness. It will be found that, as a rule, the quickest workers are the most accurate.

Conduct of the Recitation.—It is often advisable, for some purposes, to divide an arithmetic class into two sections, even where the pupils are nearly equal in attainments. The members of one section may work examples from their books while the others write the answers to oral problems given by the teacher, etc.

Where a class is thus taught in two divisions, the members of each should sit in alternate rows, extending from the front of the room to the rear. Seated in this way each pupil is doing a different kind of work from those on the right and the left, and he does not have the temptation of a neighbor’s work to lead him to compare answers.

To save time, explanations of new subjects may be given to the whole class ; but much of the arithmetic work should be done in “sections,” one of which is under the immediate direction of the teacher, while the other is employed in “seat” work. The “seat” work of pupils of the more advanced classes should consist largely of problems solved without assistance. Especial pains have been taken to grade the

Suggestions to Teachers.

problems so as to have none beyond the capacity of the average pupil. It is not necessary that all the members of a division should work the same problems at a given time, or the same number of problems, or that a new topic should be postponed until all of the previous problems have been solved.

Whenever it is possible, each of the members of the division working under the teacher's immediate direction should take part in all the work done. In mental arithmetic, for instance, while only a few may be called upon for explanations, all of the pupils should write the answers to each question. The same is true of much of the sight work, the approximations, some of the special drills, etc.

Drills and Sight Work.—To secure reasonable rapidity, it is necessary to have regular and systematic drills. These should be employed frequently, but should not last longer than five or ten minutes. A page of special sight drills is given in each chapter. These may also be used in oral problems.

It often happens that as pupils go forward in school they lose much of the readiness in oral and written work that they possessed in the lower grades, owing to the neglect of their teachers to continue to require quick, accurate review work in the operations previously taught. In this book these special drills follow the plan of the combinations of the earlier book, but gradually grow more difficult. They should first be used as sight exercises, either from the books or from the blackboard.

To secure valuable results from drill exercises, the utmost promptness in answers should be required.

Language.—While the use of correct language should be insisted upon in all lessons, children should not be required in arithmetic to give all answers in "complete sentences." Especially in the drills, it is important that the results be expressed in the fewest possible words. The teacher should be careful always to employ exact arithmetical language and to require it from the pupils.

Objective Illustrations.—The chief reason for the use of objects in the study of arithmetic is to enable pupils to work without them. While counters, weights and measures, diagrams, or the like are necessary at the beginning of some topics, it is important to discontinue their use as soon as the pupil is able to proceed without their aid.

Approximate Answers.—An important drill is furnished in the "approximations" (see Arts. 104, 180, 233, etc.). Pupils should be required in much of their written work to estimate the result before beginning to solve a problem with the pencil. Besides preventing an

absurd answer, this practice will also have the effect of causing a pupil to see what processes are necessary. In too many instances, work upon a problem is commenced before the conditions are grasped; this will be less likely to occur in the case of one who has carefully "estimated" the answer. The pupil will frequently find, also, that he can obtain the correct result without using his pencil.

Indicating Operations. — It is a good practice to require pupils to indicate by signs all of the processes necessary to the solution of a problem, before performing any of the operations. This frequently enables a pupil to shorten his work by cancellation, etc. In the case of problems whose solution requires tedious processes, some teachers do not require their pupils to do more than to indicate the operations. It is to be feared that much of the lack of facility in adding, multiplying, etc., found in the pupils of the higher classes is due to this desire to make work pleasant.

Sight Exercises. — Many pupils who find it difficult to solve problems read to them readily make the necessary calculations without a pencil when they have the numbers before them on the blackboard, or in their books. It may be found advisable to have a class first solve the whole of a given set of oral problems from their books, and at a later lesson write the answer to each question after it has been read by the teacher. In the case of sight exercises too difficult to be solved mentally, the set might be taken up one at a time by individual pupils, after which the pupils might be required to write answers "at sight" at a signal from the teacher. If the exercises are on the blackboard, the teacher might use a pointer to indicate the example whose answer was desired, not following the order in which they appeared on the blackboard. A similar method might be employed in sight work done from the books.

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AMERICA

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NEW
GRAMMAR SCHOOL ARITHMETIC.

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MIXED NUMBERS.

1. Preliminary Exercises.

How many halves in 1? How many fourths in 1? Six halves = ? 12 fourths = ? 6 thirds = ? 12 sixths = ?

$$\frac{1}{2} = ? \quad \frac{3}{2} = ? \quad \frac{5}{2} = ? \quad \frac{7}{2} = ? \quad \frac{11}{2} = ? \quad \frac{13}{2} = ?$$

Chapter One.

2. A *mixed number* is a whole number and a fraction written together.

3. A *proper fraction* is a fraction whose numerator is less than its denominator.

An *improper fraction* is a fraction whose numerator is equal to or greater than its denominator.

4. Change each of the following improper fractions to a whole number or to a mixed number:

$\frac{12}{8}$

$\frac{16}{4}$

$\frac{17}{2}$

$\frac{18}{6}$

$\frac{28}{4}$

$\frac{21}{3}$

$\frac{5}{5}$

5. Oral Exercises.

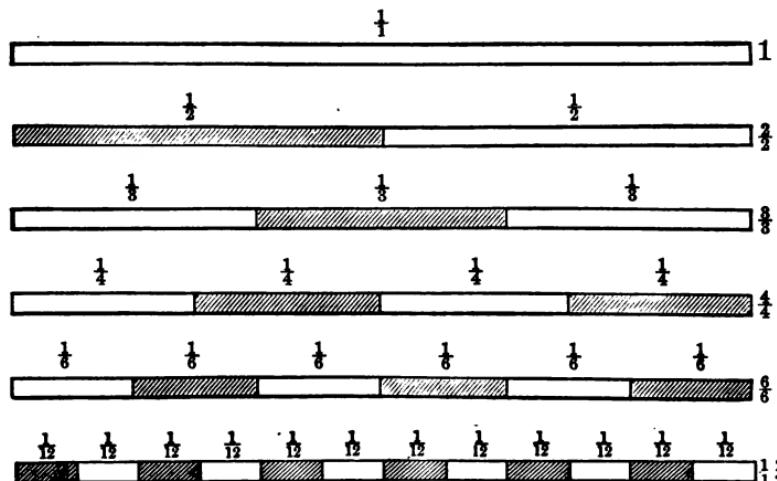
How many quarts in a gallon?

What part of a gallon is a quart?

$\frac{1}{2}$ gallon = how many quarts? $\frac{1}{2}$ = how many fourths?

How many quarts in a peck? What part of a peck is one quart? One-half peck is how many quarts? One-half = how many eighths?

$\frac{1}{4}$ peck is how many quarts? $\frac{1}{4}$ = how many eighths?
 $\frac{2}{4}$ = how many eighths? $\frac{4}{4}$ = how many eighths?



6. Draw a line one foot long. Draw a second line of the same length; divide it into halves. Divide a third line of the same length into three equal parts. Divide three other lines, one into fourths, one into sixths, and one into twelfths.

How many inches in a foot? What part of a foot is one inch? $\frac{1}{2}$ foot = how many inches? $\frac{1}{2}$ = how many twelfths?

$\frac{1}{3}$ = how many twelfths? $\frac{2}{3}$ = how many twelfths? Change $\frac{1}{4}$ to twelfths. Change $\frac{2}{4}$, $\frac{3}{4}$ to twelfths. How many twelfths = $\frac{1}{6}$? $\frac{2}{6}$? $\frac{3}{6}$? $\frac{4}{6}$? $\frac{5}{6}$? $\frac{6}{6}$?

$$\frac{1}{2} = \frac{1}{6}$$

$$\frac{1}{3} = \frac{1}{4}$$

$$\frac{1}{2} = \frac{1}{6} = \frac{1}{3}$$

$$\frac{1}{2} = \frac{1}{6} = \frac{1}{4} = \frac{1}{2}$$

$$\frac{1}{2} = \frac{1}{6} = \frac{1}{3}$$

$$\frac{1}{2} = \frac{1}{4}$$

$$\frac{1}{2} = \frac{1}{6}$$

$$\frac{1}{2} = \frac{1}{6} = \frac{1}{4} = \frac{1}{3} = \frac{1}{2}$$

How many inches in $\frac{1}{2}$ ft. + $\frac{1}{3}$ ft. + $\frac{1}{4}$ ft. + $\frac{1}{6}$ ft. + $\frac{1}{12}$ ft.? How many feet and inches?

How many 12ths in $\frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{6} + \frac{1}{12}$? Change to a mixed number. Change the fractional part to a different fraction having the same value.

What fraction of a dime is 1 cent? $\frac{1}{2}$ dime = how many cents? $\frac{1}{2} = \frac{1}{10}$.

$\frac{1}{2}$ dime = how many cents? $\frac{1}{2} = \frac{1}{10}$. Change $\frac{1}{2}$ to tenths.
 $\frac{1}{2}$. $\frac{1}{5}$. $\frac{1}{10}$.

Add $\frac{1}{2}$ dime, $\frac{1}{5}$ dime, and $\frac{1}{10}$ dime. How many cents? How many tenths = $\frac{1}{2} + \frac{1}{5} + \frac{1}{10}$? Can you change the answer to a different fraction having the same value?

7. Oral Problems.

- I spent $\frac{1}{2}$ of a dollar for a ball and $\frac{1}{10}$ of a dollar for a bat. What part of a dollar did I spend for both?
- What is the cost of a pen-knife at $\frac{1}{2}$ of a dollar, and a book at $\frac{1}{2}$ of a dollar?
- I need $\frac{1}{2}$ of a yard of ribbon for one hat and $\frac{1}{2}$ of a yard for another. How much ribbon should I buy?

Chapter One.

4. Sold $\frac{1}{2}$ of a pound of tea to one customer and $\frac{1}{4}$ to another. How much was sold to both?
5. What quantity of oats should I buy to give $\frac{3}{4}$ of a peck to one horse and $\frac{1}{2}$ to another?
6. If I sell $\frac{1}{3}$ of a dozen of oranges to one person and $\frac{1}{4}$ of a dozen to another person, what part of a dozen do I sell?
7. $\frac{2}{3}$ of an hour is how many minutes?
8. I spent $\frac{1}{2}$ of an hour reading and $\frac{3}{10}$ of an hour writing. What part of an hour did I spend at both?
9. A boy is carrying $6\frac{1}{2}$ pounds of flour, and $6\frac{1}{2}$ pounds of ham. What is the weight of his load?
10. 18 hours are what part of a day?

ADDITION OF MIXED NUMBERS.

8. In fractions the numbers above the line are called *numerators*; the numbers below the line are called *denominators*.

The numerator and the denominator are called the *terms* of a fraction.

To add fractions they must have a common denominator.

A *common denominator* is a number that will exactly contain all the denominators.

The *least common denominator* is the least number that will exactly contain all the denominators.

9. Add $12\frac{1}{2}$, $6\frac{2}{3}$, $8\frac{1}{4}$, $15\frac{5}{6}$, $\frac{3}{8}$.

	24
$12\frac{1}{2}$	12
$6\frac{2}{3}$	16
$8\frac{1}{4}$	6
$15\frac{5}{6}$	20
$\frac{3}{8}$	9
$43\frac{1}{8}$	$\frac{41}{8} = 2\frac{1}{2} = \frac{21}{4}$
	<i>Ans. $43\frac{1}{8}$.</i>

Mixed Numbers.

5

An inspection of the denominators, 2, 3, 4, 6, 8, shows that 24 is the smallest number that will contain each without remainder. This is the *least common denominator*.

Instead of writing the least common denominator 24, with each fraction, we may place it above, and write only the new numerators. $\frac{1}{2} = \frac{12}{24}$, $\frac{2}{3} = \frac{16}{24}$, $\frac{1}{4} = \frac{6}{24}$, etc. Write 12, 16, 6, 20, 9. The sum of these numerators, 63, is written over the denominator 24, making the sum of the fraction $\frac{63}{24}$. This improper fraction is reduced to $2\frac{15}{24}$, and the fractional part is reduced to $\frac{5}{8}$. $\frac{5}{8}$ is placed under the fractions to be added, and 2 is carried to the whole numbers, making 43.

Add the fractions and unite their sum with the sum of the integers.

The fractional parts of answers should be reduced to *lowest terms*.

10. Written Exercises.

Add:

1. $23\frac{1}{2}$	2. $73\frac{1}{4}$	3. $93\frac{3}{8}$	4. $11\frac{7}{8}$	5. $18\frac{1}{8}$
$63\frac{1}{4}$	$8\frac{1}{8}$	$2\frac{1}{8}$	$3\frac{1}{2}$	$7\frac{1}{8}$
$7\frac{3}{8}$	$39\frac{8}{10}$	$74\frac{5}{12}$	$20\frac{8}{14}$	$9\frac{8}{10}$
$3\frac{5}{10}$	$16\frac{1}{2}$	$6\frac{1}{8}$	$5\frac{1}{4}$	$\frac{1}{8}$
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
6. $12\frac{1}{5}$	7. $19\frac{1}{4}$	8. $73\frac{1}{4}$	9. $5\frac{1}{2}$	10. $100\frac{1}{4}$
$3\frac{5}{16}$	$7\frac{1}{8}$	$98\frac{1}{8}$	$38\frac{1}{4}$	$75\frac{1}{8}$
$27\frac{1}{4}$	$34\frac{1}{8}$	$\frac{1}{8}$	$23\frac{1}{8}$	$9\frac{1}{8}$
$8\frac{1}{2}$	$\frac{1}{8}$	$33\frac{1}{2}$	$17\frac{1}{8}$	$49\frac{1}{4}$
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
11. $33\frac{1}{3}$	12. $6\frac{1}{10}$	13. $103\frac{1}{3}$	14. $218\frac{1}{3}$	15. $444\frac{1}{3}$
$17\frac{1}{3}$	$18\frac{1}{5}$	$84\frac{1}{3}$	$301\frac{1}{3}$	$518\frac{1}{3}$
$24\frac{5}{12}$	$32\frac{1}{4}$	$25\frac{1}{2}$	$18\frac{1}{2}$	$37\frac{1}{2}$
$69\frac{1}{4}$	$94\frac{1}{2}$	$9\frac{1}{3}$	$24\frac{1}{3}$	$95\frac{1}{3}$
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>

11. Written Problems.

1. A merchant sold $17\frac{1}{4}$ yards of muslin, $14\frac{1}{2}$ yards of silk, and as many yards of calico as of the other two together. How many yards did he sell in all?
2. A boy has to walk from his home to a house $1\frac{1}{4}$ miles east of his home, and from there to a place $2\frac{1}{2}$ miles west of his home. How far has he to walk?
3. From a piece of cloth $17\frac{1}{2}$ yards, $5\frac{3}{4}$ yards, and $4\frac{3}{4}$ yards were sold. How many yards were sold?
4. A man walked $12\frac{5}{6}$ miles Tuesday, $16\frac{2}{3}$ miles Wednesday, $22\frac{7}{10}$ miles Thursday. How far did he walk in 3 days?
5. A farmer owned 3 fields containing, the first $21\frac{1}{4}$ acres, the second $27\frac{2}{3}$ acres, and the third $28\frac{9}{10}$ acres. How many acres were there in all?
6. A man bought 3 loads of wood containing respectively $1\frac{1}{4}$, cords, $1\frac{3}{4}$ cords, and $1\frac{5}{8}$ cords. How many cords of wood did he buy?
7. A man has $10\frac{1}{2}$ acres of wheat, $6\frac{2}{3}$ acres of corn, $20\frac{5}{6}$ acres of barley, $16\frac{2}{3}$ acres of rye. How many acres of grain has he?
8. William lives $24\frac{1}{4}$ rods from school, James $6\frac{8}{10}$ rods farther than William, and Charles $10\frac{1}{2}\frac{2}{3}$ rods farther than James. How far does Charles live from school?
9. Henry weighs $58\frac{3}{8}$ pounds, Peter $65\frac{3}{4}$ pounds, and John $67\frac{1}{2}$ pounds, and their father as much as all three of them. How much does their father weigh?
10. A dealer mixed $2\frac{1}{2}$ pounds of black tea costing 32 cents per pound with $1\frac{1}{2}$ pounds of green tea costing 40 cents per pound. How much per pound does the mixed tea cost him?

SUBTRACTION OF MIXED NUMBERS.

12. Preliminary Exercises.

$$1 - \frac{1}{2} = ? \quad 1\frac{1}{4} - \frac{1}{2} = ? \quad 10 - \frac{1}{2} = ? \quad 10\frac{1}{4} - \frac{1}{2} = ? \quad 10\frac{1}{4} - 1\frac{1}{2} = ?$$

In subtraction of mixed numbers, as in addition, the fractions must have a common denominator.

Subtract:

$$\begin{array}{lllll} 1. & 16\frac{1}{2} & 2. & 49\frac{1}{6} & 3. & 38\frac{2}{4} \\ & \underline{13\frac{7}{12}} & & \underline{37\frac{1}{2}} & & \underline{29\frac{1}{4}} \\ & & & & & \\ & & & & & \end{array} \quad \begin{array}{lllll} 4. & 18\frac{8}{15} & 5. & 27\frac{9}{10} & \\ & \underline{14\frac{8}{15}} & & \underline{16\frac{1}{10}} & \\ & & & & \end{array}$$

$$\begin{array}{lllll} 6. & 28\frac{7}{15} & 7. & 47\frac{7}{6} & 8. & 36\frac{11}{4} \\ & \underline{13\frac{5}{15}} & & \underline{29\frac{5}{6}} & & \underline{18\frac{5}{4}} \\ & & & & & \\ & & & & & \end{array} \quad \begin{array}{lllll} 9. & 25\frac{1}{6} & 10. & 32\frac{7}{15} & \\ & \underline{19\frac{1}{6}} & & \underline{18\frac{7}{15}} & \\ & & & & \end{array}$$

13. From $197\frac{8}{5}$ take $68\frac{4}{5}$.

$$\begin{array}{r} 197\frac{8}{5} \\ - 68\frac{4}{5} \\ \hline 128\frac{4}{5} \end{array} \quad \begin{array}{l} \text{Reduce the fractions to the least common denominator} \\ 15, \text{ as in addition of fractions. } \frac{8}{5} \text{ being greater than} \\ \frac{4}{5}, \text{ we change } 197\frac{8}{5} \text{ to } 196 + 1\frac{3}{5}, \text{ or } 196\frac{14}{5}. \quad \frac{14}{5} - \frac{4}{5} \\ = \frac{10}{5}. \quad 196 - 68 = 128. \quad \text{Ans. } 128\frac{1}{5}. \end{array}$$

Reduce the fractions to the least common denominator, and subtract the fractions and the integers separately.

14. Written Exercises.

$$\begin{array}{lllll} 1. & 35\frac{3}{4} & 2. & 63\frac{1}{2} & 3. & 27\frac{3}{8} \\ & \underline{-8\frac{3}{4}} & & \underline{-9\frac{1}{4}} & & \underline{-17\frac{1}{2}} \\ & & & & & \\ & & & & & \end{array} \quad \begin{array}{lllll} 4. & 55\frac{5}{8} & 5. & 105\frac{3}{10} & \\ & \underline{-25\frac{5}{8}} & & \underline{-8\frac{1}{4}} & \\ & & & & \end{array}$$

$$\begin{array}{lllll} 6. & 120\frac{5}{6} & 7. & 39\frac{3}{4} & 8. & 13\frac{5}{6} \\ & \underline{-84\frac{5}{6}} & & \underline{-38\frac{1}{4}} & & \underline{-7\frac{5}{12}} \\ & & & & & \\ & & & & & \end{array} \quad \begin{array}{lllll} 9. & 99\frac{5}{6} & 10. & 67\frac{3}{4} & \\ & \underline{-21\frac{5}{6}} & & \underline{-59\frac{1}{4}} & \\ & & & & \end{array} \quad \cdot$$

$$\begin{array}{lllll} 11. & 100\frac{3}{10} & 12. & 25\frac{3}{10} & 13. & 93\frac{3}{16} \\ & \underline{76\frac{3}{10}} & & \underline{5\frac{1}{2}} & & \underline{24\frac{1}{8}} \\ & & & & & \\ & & & & & \end{array} \quad \begin{array}{lllll} 14. & 101\frac{3}{11} & 15. & 12\frac{3}{8} & \\ & \underline{98\frac{3}{7}} & & \underline{4\frac{3}{8}} & \\ & & & & \end{array}$$

Chapter One.

16. $23\frac{4}{5}$	17. $9\frac{5}{18}$	18. $133\frac{3}{4}$	19. $16\frac{1}{11}$	20. $37\frac{1}{8}$
<u>$16\frac{7}{10}$</u>	<u>$3\frac{1}{8}$</u>	<u>$27\frac{7}{16}$</u>	<u>$3\frac{8}{22}$</u>	<u>$29\frac{1}{4}$</u>
21. $52\frac{3}{8}$	22. $64\frac{3}{8}$	23. $125\frac{7}{10}$	24. $47\frac{1}{5}$	25. $72\frac{1}{10}$
<u>$49\frac{5}{8}$</u>	<u>$18\frac{1}{8}$</u>	<u>$100\frac{3}{8}$</u>	<u>$8\frac{5}{8}$</u>	<u>$50\frac{1}{8}$</u>
26. $31\frac{3}{8}$	27. $63\frac{1}{5}$	28. $3\frac{1}{12}$	29. $25\frac{2}{5}$	30. $102\frac{5}{12}$
<u>$27\frac{5}{12}$</u>	<u>$44\frac{1}{5}$</u>	<u>$1\frac{1}{8}$</u>	<u>$17\frac{1}{2}$</u>	<u>$86\frac{1}{2}$</u>

15. Oral Problems.

1. A man had $\$6\frac{1}{4}$, and he spent $\$3\frac{1}{2}$. How much money had he left?
2. Take $\$8\frac{1}{4}$ from $\$12\frac{3}{4}$. How many quarters of a dollar are there in the remainder?
3. One-half of our books are in the case; we have in all 184 books; one-half of the remainder are on the table. How many are on the table?
4. If 6 apples cost 14 cents, what will 3 cost?
5. How many hours from 10 A.M. to 10 P.M.?
6. A man had 1000 acres of land and sold $996\frac{1}{4}$ acres. How many acres had he left?
7. If a man earns $\$14\frac{1}{2}$ in a week, and spends $\$8\frac{3}{4}$, how much does he save?
8. Bought sugar for $5\frac{3}{4}$ cents a pound, and sold it for $6\frac{1}{2}$ cents a pound. What was the gain on 200 pounds?
9. What will $12\frac{3}{8}$ pounds of beef cost at 16 cents a pound?
10. If a girl studies $5\frac{1}{4}$ hours in school, and $1\frac{1}{4}$ hours at home each day, how many hours does she study in a week of five days?

16. Written Problems.

1. The weight of a tub of butter, including the weight of the tub, is $48\frac{1}{4}$ pounds. The tub weighs $9\frac{1}{2}$ lb. What is the butter worth at 24 cents per pound?
2. A farmer had 7 bushels of potatoes. He used 2 bushels and 3 pecks for seed. What would the remainder be worth at 20 cents per peck?
3. How much heavier is a cheese weighing $40\frac{5}{8}$ pounds than one which weighs $26\frac{3}{4}$ pounds?
4. A farmer having 217 bushels of corn sold $95\frac{1}{4}$ bushels; how many bushels had he left?
5. A milliner gained $1\frac{1}{2}$ dollars by selling a hat for $6\frac{3}{4}$ dollars; what did it cost her?
6. From a cask of oil containing $43\frac{3}{8}$ gallons, $17\frac{1}{2}$ gallons were drawn; how many gallons remained?
7. A man having $25\frac{1}{2}$ dollars paid $6\frac{1}{2}$ dollars for coal, $2\frac{1}{2}$ dollars for dry goods, and $\frac{1}{4}$ of a dollar for a pound of tea; how much had he left?
8. A butcher buys an ox weighing alive 1200 pounds, at 6 cents per pound. When killed and dressed, its weight is $\frac{2}{3}$ of the live weight. What is the butcher's profit, if he sells the meat at an average of 15 cents per pound?
9. A farmer sold $36\frac{1}{2}$ dozen eggs to one storekeeper, $5\frac{3}{4}$ dozen to another, $17\frac{3}{4}$ dozen to a third, $8\frac{5}{8}$ dozen to a fourth, and $11\frac{1}{2}$ dozen to a fifth. How much did he receive for them at 12 cents per dozen?
10. A teacher's salary per month is $135\frac{7}{10}$ dollars, and his expenses average $51\frac{1}{2}$ dollars: how much does he save per month?
11. A man gave $\frac{1}{2}$ of his money to his wife and $\frac{1}{4}$ of it to his daughter. He divided the remainder equally among his three sons, each of whom received \$1000. How much money had he?

MULTIPLICATION OF MIXED NUMBERS.**17. Preliminary Exercises.**

$\frac{1}{4} + \frac{1}{4} + \frac{1}{4} = ?$

$3 \text{ times } \frac{1}{4} = ?$

$\frac{1}{4} \times 3 = ?$

$6 \text{ times } \frac{1}{4} = ?$

$3 \text{ times } \frac{2}{5} = ?$

$\frac{2}{5} \times 3 = ?$

$\frac{2}{5} \times 9 = ?$

$\frac{3}{8} \times 15 = ?$

$\frac{2}{5} \times 17 = ?$

$\frac{3}{4} \times 7 = ?$

$\frac{3}{7} \times 20 = ?$

$\frac{3}{7} \times 12 = ?$

$\frac{5}{6} \times 5 = ?$

$\frac{8}{9} \times 13 = ?$

$\frac{5}{6} \times 10 = ?$

18. Multiplication of a mixed number by an integer.

Find the product of $235\frac{3}{4}$ by 39.

$235\frac{3}{4}$

$\underline{39}$

Multiply 3 by 39; divide the result by 4: the quotient, $29\frac{1}{4}$, is 39 times $\frac{1}{4}$. Write the next partial product, 235×9 ; then the product of 135 by 3 tens. The sum of the three partial products gives the result, $9194\frac{1}{4}$.

$4) \underline{117}$

$\underline{291}$

$\underline{2115}$

$\underline{705}$

$\underline{\underline{9194\frac{1}{4}}} \text{ Ans.}$

19. Oral Exercises.

1. $1\frac{1}{2} \times 9 = ?$ 3. $3\frac{5}{6} \times 5 = ?$ 5. $5\frac{1}{2} \times 12 = ?$

2. $2\frac{3}{4} \times 7 = ?$ 4. $4\frac{1}{3} \times 8 = ?$ 6. $6\frac{1}{2} \times 10 = ?$

20. Written Exercises.

1. $215\frac{2}{3} \times 17 = ?$ 3. $417\frac{3}{7} \times 20 = ?$ 5. $619\frac{9}{10} \times 19 = ?$

2. $316\frac{1}{3} \times 15 = ?$ 4. $518\frac{7}{9} \times 13 = ?$ 6. $720\frac{4}{11} \times 23 = ?$

7.
$$\begin{array}{r} 163\frac{1}{4} \\ \times 75 \\ \hline \end{array}$$

9.
$$\begin{array}{r} 509\frac{1}{2} \\ \times 213 \\ \hline \end{array}$$

11.
$$\begin{array}{r} 6089\frac{1}{8} \\ \times 1004 \\ \hline \end{array}$$

8.
$$\begin{array}{r} 103\frac{1}{4} \\ \times 17 \\ \hline \end{array}$$

10.
$$\begin{array}{r} 308\frac{1}{4} \\ \times 156 \\ \hline \end{array}$$

12.
$$\begin{array}{r} 1607\frac{1}{4} \\ \times 2340 \\ \hline \end{array}$$

21. Multiplication of an integer by a mixed number.

Multiply 276 by $280\frac{1}{8}$.

Multiply 276 by the numerator, 3; divide the product by the denominator, 8; the quotient, $103\frac{1}{8}$, is the product of 276 by $\frac{3}{8}$. Multiply 276 by 8 tens and by 2 hundreds, etc.

$$\begin{array}{r}
 276 \\
 \times 280\frac{1}{8} \\
 \hline
 8)828 \\
 103\frac{1}{8} (\frac{1}{8}) \\
 2208 \\
 552 \\
 \hline
 77383\frac{1}{8} \text{ Ans.}
 \end{array}$$

To multiply a whole number by a fraction, place the product of the numerator by the whole number over the denominator, and reduce, if possible.

22. Written Exercises.

1. $13 \times 7\frac{1}{3} = ?$	4. $17 \times 10\frac{5}{12} = ?$	7. $102 \times 22\frac{1}{2} = ?$
2. $19 \times 8\frac{9}{10} = ?$	5. $21 \times 11\frac{1}{8} = ?$	8. $204 \times 34\frac{5}{6} = ?$
3. $23 \times 9\frac{4}{11} = ?$	6. $27 \times 12\frac{1}{4} = ?$	9. $468 \times 56\frac{2}{7} = ?$
10. $\begin{array}{r} 387 \\ \times 400\frac{1}{4} \\ \hline \end{array}$	12. $\begin{array}{r} 4060 \\ \times 2050\frac{1}{8} \\ \hline \end{array}$	14. $\begin{array}{r} 3579\frac{1}{16} \\ \times 4300 \\ \hline \end{array}$
11. $\begin{array}{r} 698 \\ \times 135\frac{1}{8} \\ \hline \end{array}$	13. $\begin{array}{r} 3050 \\ \times 2060\frac{1}{4} \\ \hline \end{array}$	15. $\begin{array}{r} 4987\frac{1}{16} \\ \times 2469 \\ \hline \end{array}$

23. Oral Problems.

1. How many ounces in $6\frac{1}{2}$ pounds?
2. I sold $3\frac{1}{2}$ yards of silk and $2\frac{3}{4}$ yards of velvet. How many yards in all did I sell?
3. From 60 take 24. Find $\frac{1}{4}$ of the remainder.
4. $\frac{2}{3}$ of 100 rods = ?
5. $(\frac{2}{3} \text{ of } 60) + 9 = ?$
6. $\frac{2}{3}$ of 81 yards = ?
7. $\frac{2}{3}$ of 56 pounds = ?

8. $\frac{3}{4}$ of a yard and 12 inches are how many inches?
9. If one-half a pound of soap costs 10 cents, what will three pounds cost?
10. John is going a journey of 100 miles; if he travels $\frac{2}{3}$ of the distance in the cars and the rest in a coach, how many miles will he travel in the coach?
11. How many times must I fill my glass, which holds $\frac{1}{2}$ a pint, to fill my pitcher, which holds a gallon?
12. If a boy is in school $5\frac{1}{4}$ hours a day, how many hours is he in school in 200 days?

24. Written Problems.

1. What is meant by $\frac{1}{3}$ of any number or thing? Make a drawing to show what you mean.
2. What is the cost of $15\frac{1}{2}$ acres of land at \$45 an acre?
3. Reduce $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{4}{15}$ to fractions having a common denominator.
4. What is the cost of a side of beef containing 252 pounds at $9\frac{1}{4}$ cents a pound?
5. A hotel uses $18\frac{3}{4}$ pounds of beef in a day. What will be the weekly bill at 22 cents a pound?
6. A man walks $3\frac{1}{4}$ miles in one hour. How far can he walk in 9 hours?
7. From a piece of muslin containing $37\frac{1}{2}$ yards, three pieces each measuring $7\frac{1}{2}$ yards were sold. How much remained in the piece?
8. At \$7.86 a barrel, what will $18\frac{5}{8}$ barrels of flour cost?
9. Bought 6 bushels of apples at $62\frac{1}{2}$ cents a bushel, and sold them at $12\frac{1}{2}$ cents a half-peck. What was the gain?
10. In a school containing 945 pupils $\frac{2}{3}$ of the number were boys; how many boys in the school?
11. What is the cost of 15 acres of land at \$45 $\frac{1}{4}$ an acre?

12. If a quart of cream is worth 22 cents, what are two gallons worth?

13. At 9 cents a quart, what is the cost of $2\frac{1}{2}$ gallons of vinegar?

14. What is the total quantity of molasses in 4 casks containing, respectively, $40\frac{1}{4}$, $25\frac{1}{2}$, $27\frac{3}{16}$, and $55\frac{1}{4}$ gallons?

15. The Post-office Department bought 6670 pounds of twine at $19\frac{1}{2}$ cents a pound; 372 pounds of sponge at $65\frac{1}{2}$ cents a pound, and $40\frac{1}{2}$ dozen of ink at \$2 a dozen. What was the total cost of the purchase?

DIVISION OF MIXED NUMBERS.

25. Preliminary Exercises.

How many times is $\frac{1}{2}$ of a dollar contained in \$1? How many times is $\frac{1}{2}$ of a pint contained in 1 pint? $\frac{1}{2}$ of a gallon in 1 gallon?

How many times is $\frac{1}{2}$ of a dollar contained in \$2? In \$3? In \$5?

How many times is $\frac{1}{2}$ of a dollar contained in \$1.50? In \$2.50? In \$3.50? In \$4.50?

How many times is 1 half contained in 3 halves? In 5 halves? In 7 halves? In 9 halves?

$$\frac{3}{2} + \frac{1}{2} = ? \quad \frac{5}{2} + \frac{1}{2} = ? \quad \frac{7}{2} + \frac{1}{2} = ? \quad \frac{9}{2} + \frac{1}{2} = ?$$

How many times is $\frac{3}{2}$ contained in $\frac{9}{2}$? In $\frac{5}{2}$? In $\frac{15}{2}$? In $\frac{21}{2}$?

Divide $1\frac{1}{2}$ by $1\frac{1}{2}$. $4\frac{1}{2}$ by $1\frac{1}{2}$. $7\frac{1}{2}$ by $1\frac{1}{2}$. $10\frac{1}{2}$ by $1\frac{1}{2}$.

Divide 3 by $1\frac{1}{2}$. 6 by $1\frac{1}{2}$. 9 by $1\frac{1}{2}$. 12 by $1\frac{1}{2}$. 15 by $1\frac{1}{2}$.

Divide 5 by $1\frac{1}{2}$. $6\frac{1}{2}$ by $1\frac{1}{2}$. 10 by $1\frac{1}{2}$. $11\frac{1}{2}$ by $1\frac{1}{2}$. 15 by $1\frac{1}{2}$.

Divide $\frac{3}{4}$ by $\frac{1}{4}$. $\frac{5}{4}$ by $\frac{1}{4}$. $1\frac{1}{4}$ by $\frac{1}{4}$. $1\frac{1}{2}$ by $\frac{1}{4}$. $2\frac{1}{4}$ by $\frac{1}{4}$.
3 by $\frac{1}{4}$. $3\frac{1}{4}$ by $\frac{1}{4}$.

26. Written Exercises.

1. Divide 250 by $12\frac{1}{2}$.

$$250 = 500 \text{ halves.} \quad 12\frac{1}{2} = 25 \text{ halves.}$$

$$500 \text{ halves} \div 25 \text{ halves} = 500 \div 25 = 20, \text{ Ans.}$$

$$\text{Proof: } 20 \times 12\frac{1}{2} = 250.$$

2. Divide $62\frac{1}{2}$ by 25.

$$62\frac{1}{2} = 125 \text{ halves.} \quad 25 = 50 \text{ halves.}$$

$$125 \text{ halves} \div 50 \text{ halves} = 125 \div 50 = 2\frac{1}{2} = 2\frac{1}{2}, \text{ Ans.}$$

$$\text{Proof: } 25 \times 2\frac{1}{2} = 62\frac{1}{2}.$$

3. Divide $1387\frac{1}{2}$ by $18\frac{3}{4}$.

$$18\frac{3}{4} = 75 \text{ fourths.}$$

$$\begin{array}{r} \text{Ans.} \quad 74 \\ 75) 5550 \\ \underline{-525} \\ \qquad \qquad \qquad 300 \\ \qquad \qquad \qquad \underline{300} \end{array}$$

Change $1387\frac{1}{2}$ to fourths by multiplying by 4.

$$1387\frac{1}{2} \times 4 = 5550; \text{ that is, } 1387\frac{1}{2} = 5550 \text{ fourths.}$$

75 fourths is contained in 5550 fourths 74 times.

Reduce the dividend and the divisor to improper fractions of the same denominator, and divide the numerator of the dividend by the numerator of the divisor. Prove the correctness of the answer by multiplying the quotient by the divisor.

27. Written Exercises.

Divide:

- | | | |
|----------------------------|------------------------------|---|
| 1. $60 \div \frac{1}{2}$ | 11. $75 \div 12\frac{1}{2}$ | 21. $62\frac{1}{2} \div 12\frac{1}{2}$ |
| 2. $60 \div 1\frac{1}{2}$ | 12. $150 \div 12\frac{1}{2}$ | 22. $187\frac{1}{2} \div 12\frac{1}{2}$ |
| 3. $60 \div \frac{1}{3}$ | 13. $75 \div 6\frac{1}{4}$ | 23. $81\frac{1}{4} \div 6\frac{1}{4}$ |
| 4. $60 \div 1\frac{1}{3}$ | 14. $150 \div 6\frac{1}{4}$ | 24. $193\frac{1}{4} \div 6\frac{1}{4}$ |
| 5. $60 \div \frac{1}{4}$ | 15. $62 \div 15\frac{1}{2}$ | 25. $77\frac{1}{2} \div 15\frac{1}{2}$ |
| 6. $60 \div 1\frac{2}{3}$ | 16. $105 \div 17\frac{1}{2}$ | 26. $192\frac{1}{2} \div 17\frac{1}{2}$ |
| 7. $60 \div \frac{2}{3}$ | 17. $69 \div 5\frac{3}{4}$ | 27. $97\frac{1}{4} \div 5\frac{3}{4}$ |
| 8. $60 \div 2\frac{1}{2}$ | 18. $93 \div 7\frac{3}{4}$ | 28. $193\frac{1}{4} \div 7\frac{3}{4}$ |
| 9. $60 \div \frac{3}{4}$ | 19. $100 \div 33\frac{1}{3}$ | 29. $166\frac{2}{3} \div 33\frac{1}{3}$ |
| 10. $60 \div 3\frac{1}{3}$ | 20. $150 \div 16\frac{2}{3}$ | 30. $133\frac{1}{3} \div 16\frac{2}{3}$ |

31. $60\frac{1}{2} + 2$

32. $60 + 7\frac{1}{2}$

33. $15\frac{3}{4} + 1\frac{1}{4}$

34. $87\frac{1}{2} \div 6\frac{1}{4}$

35. $62\frac{1}{2} \div 6\frac{1}{4}$

36. $60\frac{3}{4} \div 3$

37. $60 + 3\frac{3}{4}$

38. $24\frac{1}{2} \div 1\frac{1}{4}$

39. $87\frac{1}{2} \div 8\frac{1}{4}$

28. Oral Problems.

1. I paid 18 cents for $1\frac{1}{2}$ pounds of lard. What is the price per pound?

36 cents for 3 pounds.

2. At $\frac{1}{4}$ dollar per yard, how many yards of silk can be bought for \$9?

36 quarter dollars = 3 quarter dollars.

3. If one fish cost 25 cents, how much would $2\frac{1}{2}$ fish cost?

4. A man bought 30 apples at the rate of 3 for 5 cents. How much did he give for them?

5. If I pay 6 cents for a dozen apples, how much does each apple cost?

6. How many times is $4\frac{1}{2}$ contained in 27?

7. If $2\frac{1}{2}$ bushels of oats will keep a horse one week, how long will 18 bushels keep him?

8. If \$97 is $\frac{1}{4}$ of a sum of money, what is that sum?

9. What is the cost of 12 doz. eggs at the rate of 2 eggs for 3 cents?

10. If 3 boys can cut a cord of wood in 8 hours, how long will it take 4 boys to cut a cord?

11. If $\frac{1}{2}$ of a melon costs 15 cents, what will two melons cost at the same rate?

12. It takes $2\frac{1}{2}$ yards of cloth for a pair of trousers. How many pairs can be made from 30 yards of cloth?

13. Paid \$12.90 for 3 pieces of lace. How much did each cost?

14. If 3 straw hats cost 63 cents, what will be the cost of 5?

29. Written Problems.

1. A farmer distributed 15 bushels of corn among several persons, giving them $1\frac{1}{2}$ bushels apiece; among how many persons did he divide it?
 2. A man bequeathed to his son \$3500, which was $\frac{5}{7}$ of what he left his wife. How much did he leave his wife?
- SUGGESTION. — $\frac{5}{7}$ of wife's share = \$3500. Multiplying by 7:—
- 5 times wife's share = \$24,500.
3. If $\frac{2}{3}$ of a farm is valued at \$1728, what is the value of the whole?
 4. A man walks $4\frac{1}{2}$ miles in one hour, how far can he walk in 9 hours?
 5. At $\frac{4}{5}$ of a cent a foot, how many feet of wire can be bought for \$1.26?
 6. The sum of $69\frac{1}{2}$ dollars was divided equally among 5 men; what was each one's share?
 7. At $\frac{7}{8}$ dollars per yard, how many yards of cloth can be purchased for \$98?
 8. In how many days can a horse eat 66 bushels of oats if he eats $\frac{2}{3}$ of a bushel a day?
 9. A man bought chairs at $4\frac{3}{4}$ dollars apiece for 114 dollars, and then sold them at $6\frac{1}{4}$ dollars apiece; how much did he gain?
 10. A man sold $9\frac{5}{8}$ bushels of seed for \$61.60; find the price per bushel.
 11. What part of 24 is 3? What part of $24\frac{1}{2}$ is $3\frac{1}{2}$?
 12. What would be the cost of $24\frac{1}{2}$ pounds of beans at the rate of 11 cents for $3\frac{1}{2}$ pounds?

30. Notation and Numeration.

The largest number that can be written with six figures is 999,999.

1,000,000, is called one million.

Write in figures two million. Three million. Four million. Six million. Eight million. Ten million.

31. Read the following:

- | | | |
|--------------|----------------|-----------------|
| 1. 1,234,567 | 6. 11,034,065 | 11. 30,100,021 |
| 2. 3,000,560 | 7. 14,602,500 | 12. 35,000,600 |
| 3. 5,009,008 | 8. 17,386,925 | 13. 401,023,160 |
| 4. 7,090,070 | 9. 20,007,316 | 14. 760,030,020 |
| 5. 9,843,000 | 10. 25,000,005 | 15. 980,750,000 |

32. Write in figures:

1. Seventy-eight million, one hundred eight thousand, ninety-six.
2. Three million, eight.
3. Fourteen million, seven thousand, five.
4. Nine hundred eighty-seven thousand, six hundred fifty-four.
5. Twenty million, thirty thousand, forty.
6. Three hundred seven million, nine hundred four thousand, six.
7. Nine hundred ninety-nine million, nine hundred ninety-nine thousand, nine hundred ninety-nine.
8. Four hundred seventy-six million, three hundred thousand.
9. Thirty-four thousand, eighteen.
10. Sixty-four million, thirty-two thousand, sixteen.
11. Add the foregoing.

Chapter One.

REVIEW OF FUNDAMENTAL OPERATIONS.

Practice in the fundamental operations should not be neglected. Business men complain that elementary and high school graduates cannot add.

Read the following numbers. Add each column.

1.	27,083,549	2.	508,900,007	3.	243,576,908
	3,006,005		4,629,880		5,987,600
	20,080,070		25,936,097		380,070
	1,647,893		134,870,603		68,000
	206,045		59,009,300		593,056
	73,000		7,000,004		2,384,672
	180,059		686,909		59,876,004
<hr/>					
4.	9,256,874	5.	348	6.	7,293
	863,052		2,967		82,538
	24,635,998		36,847		786,324
	7,007,007		243,837		94,649
	6,875,634		183,634		256,834
	3,987,456		986,246		3,983,387
	35,068		8,216		54,619
	705		586,237		760,888
<hr/>					

33. Oral Exercises.

Give answers:

- | | | | |
|---------------------------|----------------------------|----------------------------|----------------------------|
| 1. 1200×6 | 6. 1300×9 | 11. 2100×4 | 16. 1400×8 |
| 2. 1800×4 | 7. 2300×3 | 12. 1400×6 | 17. 2400×4 |
| 3. 2500×3 | 8. 3200×2 | 13. 4100×2 | 18. 1300×7 |
| 4. 1700×5 | 9. 1500×4 | 14. 1600×5 | 19. 1200×9 |
| 5. 1400×7 | 10. 1200×8 | 15. 2200×3 | 20. 6300×2 |

Review of Fundamental Operations. 19

34. Written Exercises.

Multiply:

1. $9,207 \times 3014$

7. $95 \times 95 \times 95$

2. $5,482 \times 798\frac{1}{2}$

8. $185 \times 19 \times 78$

3. $5,290 \times 6075$

9. $87\frac{1}{4} \times 23 \times 36$

4. $9,204 \times 678\frac{7}{8}$

10. $706 \times 304 \times 509$

5. $75,074 \times 395$

11. $48\frac{3}{4} \times 32 \times 74$

6. $68,431 \times 924\frac{3}{5}$

12. $538 \times 247 \times 125$

35. Oral Exercises.

Divide:

1. $960 \div 240$

6. $8400 \div 2100$

11. $10800 \div 1200$

2. $780 \div 260$

7. $8600 \div 4300$

12. $10400 \div 1300$

3. $960 \div 480$

8. $8800 \div 2200$

13. $6000 \div 1500$

4. $720 \div 180$

9. $9600 \div 3200$

14. $5700 \div 1900$

5. $2170 \div 310$

10. $9900 \div 3300$

15. $12000 \div 2400$

The foregoing exercises are given as a preparation for the long division drill that follows. Each of the above set has an exact quotient, easily determined at sight.

The object of the following set is to drill pupils to obtain rapidly the correct quotient figure in a long division example. A pupil giving 4 as the answer to No. 1 should be asked to give the product of 241 by 4.

36. Long division drill. (Omit remainders.)

1. $960 \div 241$

6. $8,400 \div 2110$

11. $10,800 \div 1205$

2. $779 \div 260$

7. $8,500 \div 4300$

12. $10,300 \div 1300$

3. $959 \div 480$

8. $8,800 \div 2199$

13. $6,100 \div 1550$

4. $720 \div 181$

9. $9,599 \div 3199$

14. $5,700 \div 1899$

5. $1160 \div 130$

10. $10,000 \div 3330$

15. $12,020 \div 2410$

Chapter One.

37. Divide:

- | | |
|------------------------|--------------------------|
| 1. $34,463 \div 370$ | 7. $703,705 \div 12,345$ |
| 2. $823,150 \div 1298$ | 8. $420,135 \div 6,789$ |
| 3. $639,712 \div 624$ | 9. $370,088 \div 5,986$ |
| 4. $345,738 \div 7210$ | 10. $510,940 \div 4,900$ |
| 5. $861,704 \div 351$ | 11. $639,215 \div 9,783$ |
| 6. $857,384 \div 3004$ | 12. $345,678 \div 7,095$ |

38. Sight Exercises.

NOTE. — First, combine the quantities within the parentheses, (); next, complete the combinations within the brackets, [], if any; then perform the remaining operations.

$$\begin{aligned} 28 + (40 + 2) &= 28 + 20 \\ [30 + (6 + 2)] \times 5 &= [30 + 8] \times 5 = 10 \times 5 \end{aligned}$$

Perform indicated operations at sight:

- | | |
|---|--|
| 1. $18 + (30 \times 4)$ | 7. $\frac{1}{2}$ of $(240 + 60)$ |
| 2. $7 + (2 \times 8) - 4$ | 8. $(7 + 2) \times (8 - 4)$ |
| 3. $[(7 + 2) \times 8] - 4$ | 9. $7 + [2 \times (8 - 4)]$ |
| 4. $1 - (\frac{1}{2} + \frac{1}{2})$ | 10. $1 - \frac{1}{2} + \frac{1}{2}$ |
| 5. $(6 \times \frac{1}{2}) + \frac{1}{2}$ | 11. $6 \times (\frac{1}{2} + \frac{1}{2})$ |
| 6. $\frac{1}{2}$ of $\frac{1}{2}$ of 600 | 12. $\frac{3}{4} \times 12 \times \frac{2}{3}$ |

SPECIAL DRILLS.

NOTE. — In adding, subtracting, and multiplying without using the pencil, it is inadvisable to begin with the units: 58 and 34, for instance, are more readily combined mentally, by adding 58 and 30 (88) and 4. In the recitation, the pupil should say 88, 92; or 92, merely.

$$630 + 280 = 630 + 200 + 80.$$

39. Give sums:

- | | | | |
|---------|---------|-----------|----------|
| 56 + 25 | 32 + 48 | 750 + 190 | 225 + 54 |
| 47 + 47 | 29 + 28 | 390 + 120 | 315 + 21 |
| 22 + 68 | 65 + 26 | 480 + 150 | 437 + 60 |

Review of Fundamental Operations. 21

40. Give remainders:

$$92 - 58 = 92 - 50 - 8. \text{ Say } 42, \mathbf{34}.$$

$$840 - 280 = 840 - 200 - 80. \text{ Say } 640, \mathbf{560}.$$

$81 - 56$	$750 - 190$	$750 - 560$	$279 - 54$
$94 - 47$	$510 - 120$	$510 - 390$	$386 - 63$
$60 - 28$	$630 - 150$	$630 - 480$	$457 - 37$
$72 - 39$	$820 - 160$	$820 - 660$	$568 - 25$

41. Give products:

$$87 \times 2 = (80 \times 2) + (7 \times 2). \text{ Say, } 160, \mathbf{174}.$$

410×6	83×7	43×5	12×70
310×9	99×2	26×7	18×30
420×4	65×3	24×8	16×40
630×3	49×4	22×9	13×50
740×2	37×5	18×11	11×60

42. Give quotients:

$168 \div 3$	$168 \div 56$	$1470 \div 7$	$1470 \div 210$
$196 \div 4$	$196 \div 49$	$2790 \div 9$	$2790 \div 310$
$190 \div 5$	$190 \div 38$	$1680 \div 4$	$1680 \div 420$
$192 \div 6$	$192 \div 32$	$1890 \div 3$	$1890 \div 630$
$196 \div 7$	$196 \div 28$	$1480 \div 2$	$1480 \div 740$

43. Give answers:

$2\frac{1}{4} + 1\frac{1}{8}$	$1\frac{1}{8} - \frac{1}{2}$	$\frac{4}{5} \text{ of } 66$	$12\frac{1}{2} \div \frac{1}{2}$
$2\frac{1}{4} + 1\frac{1}{8}$	$2\frac{1}{4} - 1\frac{1}{8}$	$84 \times \frac{4}{5}$	$8\frac{1}{4} + \frac{3}{4}$
$2\frac{1}{4} + 1\frac{1}{2}$	$3\frac{1}{2} - 2\frac{1}{2}$	$\frac{4}{5} \text{ of } 100$	$5\frac{1}{8} + \frac{3}{8}$
$2\frac{1}{4} + 1\frac{1}{8}$	$4\frac{1}{8} - 3\frac{1}{4}$	$186 \times \frac{4}{5}$	$3\frac{1}{8} + \frac{3}{8}$
$2\frac{1}{4} + 1\frac{1}{8}$	$5\frac{1}{4} - 4\frac{1}{8}$	$\frac{4}{5} \text{ of } 120$	$4\frac{1}{8} + \frac{3}{8}$

44. Oral Problems.

1. Paid 59¢ for muslin and 25¢ for trimming. How much was paid for both?
2. A boy had 75¢. How much had he after spending 25¢ for a knife and 15¢ for a ball?
3. If 8 pounds of raisins cost \$1.04, what is the price per pound?
4. At \$1.89 per yard of silk, what will be the cost of $\frac{1}{3}$ of a yard?
5. If 32 pounds of flour cost 96 cents, how many pounds can be bought for 60 cents?
6. One girl has 16 cents, another has 24 cents, a third has 8 cents. How many dolls at 16 cents each can be bought with their money?
7. What will be the weight of 3 bushels of corn, weighing 56 pounds per bushel?
8. How many ounces in 9 pounds avoirdupois?
9. How many pounds in 8 packages, each weighing 10 ounces?
10. Find the cost of 3 pounds and 2 ounces of butter at 32 cents per pound.
11. Bought 4 pounds of sugar at 6 cents a pound, and a pound of butter at 36 cents. How much change from \$1?
12. Four boys have 144 marbles among them. If the marbles were equally divided, how many would each have?
13. A man earns \$100 per month, and spends \$76. How much does he save?
14. If a man saves \$32 per month, how many months will it take him to save \$960?
15. Paid \$27.90 for 9 jackets. What did they cost apiece? .

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16. Mr. B's farm contains 520 acres. How many acres will he have left after selling 180 acres?
17. William's kite string is 435 yards long, John's is 62 yards longer. What is the length of John's string?
18. A farmer raised 168 bushels of grain. He sold $\frac{1}{3}$ of it. How many bushels did he sell?
19. A piece of ribbon measuring $6\frac{1}{4}$ yards is cut into pieces a quarter of a yard long. How many pieces are there?
20. If it takes $18\frac{1}{4}$ yards of cloth to make 3 suits, how many yards does it take for 1 suit?
21. James has 150 marbles, Thomas has $\frac{2}{3}$ as many. How many marbles have both?
22. A newsdealer received \$6.36 for papers sold at 3 cents each. How many papers did he sell?
23. If it takes $4\frac{1}{2}$ days for one man to do a piece of work, how long will it take 2 men to do the same work?
24. A farm is divided into 4 fields, each containing 49 acres. How many acres are there in the farm?
25. From a piece of cloth containing $10\frac{1}{4}$ yards, $5\frac{3}{4}$ yards are sold. How many yards are left?
26. Find the cost of 28 pounds coffee at $\$1\frac{1}{4}$ per pound.
27. How much does a farmer receive for 28 cows which he sells at \$30 each?
28. Find the number of hours in a week.
29. How many pieces, each three-quarters of a yard long, can be cut from six yards of wire?
30. 3600 seconds are equal to how many minutes?
31. If 25 yards of material are needed for a dress, how many yards will be required for 30 dresses?
32. At 7 for a cent, what will 98 marbles cost?

45. Written Problems.

1. The sum of three numbers is 150. Two of the numbers are 68 and 43. What is the third?

$$68 + 43 + ? = 150$$

2. The divisor is 24; the dividend is 264. Find the quotient.

3. The product is 228; the multiplicand is 19. What is the multiplier?

$$19 \times ? = 228$$

4. The minuend is 175; the subtrahend is 87. What is the remainder?

5. The remainder is 92; the subtrahend is 89. Find the minuend.

$$? - 89 = 92$$

6. The minuend is 176, and the remainder is 99. What is the subtrahend?

7. The multiplier is 15; the multiplicand is 46. What is the product?

8. The multiplier is 16; the product is 272. What is the multiplicand?

9. The dividend is 300; the divisor is 17. Find the remainder.

10. The quotient is 15; the remainder is 3; the divisor is 8. What is the dividend?

$$\begin{array}{r} 8) \underline{\quad ?} \\ \underline{15} \end{array}$$

11. The dividend is 273; the quotient is 21. What is the divisor?

12. The dividend is 267; the quotient is 13; the remainder is 7. What is the divisor?

$$\begin{array}{r} ?) \underline{267} \\ \underline{137} \end{array}$$

13. How many acres of land could you buy for \$76,225, if one acre cost \$37?

NOTATION OF DECIMALS.

46. A *decimal fraction* is one in which the unit is divided into tenths, hundredths, thousandths, etc.

47. Preliminary Exercises.

In the number 25, what does the 2 stand for?

In the number 467, what does the 4 represent? The 6? The 7?

In the number 33,333, give the value of the first 3 (commencing at the left). Of the second. Of the third. Of the fourth. Of the fifth.

The last 3 is what part of the number represented by the fourth 3? The third 3 is what part of the second? Each 3 is what part of the 3 to its left? Upon what does the value of each 3 in this number depend?

In the number XXXIII, what is the value of the first X? Of the second? Of the third?

When we write \$784.365, the 7 stands for seven times how many dollars? The 8 for eight times how many dollars? The 4 for four times how many dollars? The 3 stands for three times what part of a dollar? The 6 stands for six times what part of a dollar? The 5 stands for five times what part of a dollar?

Hundreds. Tens. Units. Decimal Point. Tenths. Hundredths. Thousandths.

7	8	4	.	3	6
---	---	---	---	---	---

784.365 is read 784 *and* 365 thousandths.

37.5 is read 37 *and* 5 tenths.

6.492 is read 6 *and* 492 hundredths.

400.75 is read 400 units *and* 75 hundredths.

NOTE. — In reading a number containing an integer and a decimal, the word *and* may be placed between the two, as is shown above. To avoid mistakes, the word *units* should be used after the integer in reading such numbers as 200.005. Say: Two hundred units and five thousandths.

48. Read the following:

- | | | |
|---------|----------|------------|
| 1. .7 | 5. 3.275 | 9. 100.025 |
| 2. 34.9 | 6. 32.4 | 10. .125 |
| 3. .36 | 7. 1.025 | 11. .005 |
| 4. .95 | 8. .35 | 12. 1.348 |

49. Express in decimals:

1. 7 tenths.
2. 36 and 47 thousandths.
3. One hundred twenty-five thousandths.
4. One hundred units and twenty-five thousandths.
5. 47 hundredths.
6. Four hundred units and six tenths.
7. Four hundred six thousandths.
8. 3 and 56 hundredths.
9. 65 hundredths.
10. 6 and 5 tenths.

Note. — Since $\frac{50}{100}$ equals $\frac{5}{10}$, $.50 = .5$. The cipher at the right of .50 has, therefore, no value. $\frac{700}{1000} = \frac{7}{10}$; .700 is, therefore, the same as .7. In giving answers, reject ciphers at the right of the decimal.

ADDITION OF DECIMALS.

50. Add:

1. .7	2. 3.84	3. 28.978	4. 5.6
4.18	68.075	.28	.387
.005	.5	5.375	26.93
5.67	24.698	<u>18.758</u>	<u>8.754</u>
<u>10.555</u>	<u>97.113</u>		

Write the numbers so that the decimal points stand in a column. Add as in whole numbers, and place the point in the sum directly under the points in the addends.

51. Written Exercises.

1. $.027 + 1.39 + 48.6 + 72.978$
2. $234.96 + .675 + 50.4 + 6.02 + 1.001$
3. $3.047 + 54.79 + .097 + .76 + .862$
4. $.8 + .38 + .479 + 27.87 + 375$
5. $.445 + 34.75 + 306.973 + .004 + 48.56$
6. $.81 + 12.654 + 234.79 + 8.6 + .603 + 42.96$
7. $45.78 + .237 + 6.987 + 18 + 372.003 + 37.5$
8. $4.745 + 36.58 + 725.894 + 9.87 + 75.357 + 86.74$
9. $59.3 + 83 + 9.64 + 48.565 + 6.98 + 8.795 + 963.826$
10. $13.387 + 72.563 + .7 + .603 + 7.245 + .483 + 9.25$
11. $8.3 + 2.576 + 3.42 + 1.5 + 6.279 + .003 + 1.417$

SUBTRACTION OF DECIMALS.

52. From 37 take 3.7.

37 may be written 37.0
 subtract $\frac{3.7}{33.3}$ Ans.

In practice, the pupil should not waste time in writing the unnecessary ciphers at the right of the decimals in the minuend.

182.01	1.	28.6
$\underline{- 4.624}$	$\underline{- .009}$	$\underline{- 1.003}$
177.386	.991	27.597

Write the numbers so that the decimal point in the subtrahend stands directly under the decimal point in the minuend. Subtract as in whole numbers, and place the point in the remainder under the points above.

53. Written Exercises.

Find answers:

- | | | |
|---------------|----------------|----------------|
| 1. $1 - .057$ | 3. $6 - 3.324$ | 5. $3 - 1.568$ |
| 2. $1 - .245$ | 4. $4 - 2.491$ | 6. $7 - 4.736$ |

- | | |
|------------------------|-----------------------|
| 7. $3.587 - 1.34$ | 14. $681.38 - 94.572$ |
| 8. $91.352 - 72.456$ | 15. $1000 - 465.874$ |
| 9. $42.007 - 17.658$ | 16. $30.053 - 18.7$ |
| 10. $68.217 - 39.4$ | 17. $2568.91 - 1925$ |
| 11. $9.34 - 5.672$ | 18. $1.234 - .825$ |
| 12. $45.268 - 23.068$ | 19. $473.5 - 298.572$ |
| 13. $219.843 - 187.95$ | 20. $57.083 - 44.95$ |

MULTIPLICATION OF A DECIMAL BY AN INTEGER.

54. Three times 3 tenths equals how many tenths?

$$.3 \times 3 = \text{what?} \quad .3 \times 4 = ? \quad .3 \times 12 = ?$$

1. Multiply 2.7 by 8.

$$\begin{array}{r} 8 \text{ times } 7 \text{ tenths} = 56 \text{ tenths} = 5.6. \text{ Write } .6. \\ 2 = 16; \text{ carry } 5. \end{array} \quad \begin{array}{r} 2.7 \\ \times 8 \\ \hline \text{Ans. } 21.6 \end{array}$$

2. Multiply .275 by 12.

$$\begin{array}{r} \text{The product of } 275 \text{ thousandths by } 12 \text{ is } 3300 \text{ thousandths,} \\ \text{which equals } 3 \text{ and } 300 \text{ thousandths, or } 3 \text{ and } 3 \text{ tenths.} \end{array} \quad \begin{array}{r} .275 \\ \times 12 \\ \hline 3.300 \end{array}$$

Ans. 3.3

Multiply as in whole numbers, and point off in the product decimal places equal to the number in the multiplicand, rejecting unnecessary ciphers at the right of the decimal.

55. Written Exercises.

Multiply:

- | | |
|---------------------|-----------------------|
| 1. $.36 \times 3$ | 6. $.048 \times 375$ |
| 2. 57.2×7 | 7. 12.67×300 |
| 3. 6.4×122 | 8. 6.57×9 |
| 4. $.67 \times 4$ | 9. 8.76×43 |
| 5. 38.4×25 | 10. 005×360 |

56. Oral Exercises.

Give products:

1. 6.84×10
2. 68.4×10
3. 3.28×10
4. 5.71×100
5. 5.71×1000

6. $.961 \times 100$
7. $.57 \times 1000$
8. $.09 \times 1000$
9. $.026 \times 100$
10. 5.17×10

NOTE. — The pupil should deduce the rule for multiplying a decimal by 10, 100, 1000.

57. To multiply an integer by a decimal.

Multiply 35 by 6.4.

35	6.4
<u>6.4</u>	<u>35</u>
14.0	product of 35 by 6.4 is equal to the
210	product of 6.4 by 35, there will be one decimal
<u>224.0</u>	place in the product.
<i>Ans.</i> 224.	<u>32.0</u>
	<u>192</u>
	<u>224.0</u>

In multiplying an integer by a decimal, or a decimal by an integer, point off in the product as many decimal places as there are decimal places in the multiplier or the multiplicand.

58. Multiply:

1. 122 by 6.4
2. 512 by .003
3. .056 by 987
4. 97 by .005
5. 275 by 1.2

6. 5430 by .8
7. 748 by .97
8. 964 by .347
9. 570 by .11
10. 570 by 1.1

DIVISION OF A DECIMAL BY AN INTEGER.

59. Preliminary Exercises.

- | | |
|-------------------|------------------|
| 1. $8.64 \div 2$ | 6. $.666 \div 6$ |
| 2. $48.24 \div 4$ | 7. $.048 \div 8$ |
| 3. $.465 \div 4$ | 8. $.81 \div 9$ |
| 4. $8.40 \div 5$ | 9. $.12 \div 5$ |
| 5. $8.4 \div 5$ | 10. $.34 \div 4$ |

60. Where it is necessary, ciphers may be annexed to the right of the decimal in the dividend.

1. $8) \underline{.12}$.015	2. $15) \underline{.06}$.004	5. $64) \underline{120}.$ $\frac{64}{56.0}$
$.012$	$.413$	$\frac{51.2}{4.80}$
3. $125) \underline{1.50}$ $\underline{1.25}$.250	4. $21) \underline{8.673}$ $\underline{8.4}$.27	$\frac{4.48}{.320}$
$.250$	$.21$	$\frac{.320}{.063}$
		$\underline{.063}$

In dividing a decimal by an integer, point off in the quotient as many decimal places as there are decimal places in the dividend (including the ciphers annexed).

NOTE.—In practice, however, the decimal point may be placed in the quotient under (or over) the decimal point in the dividend.

61. Written Exercises.

Divide:

- | | |
|----------------------------|------------------------------|
| 1. $25) \underline{1.00}$ | 6. $11) \underline{70.07}$ |
| 2. $4) \underline{21.80}$ | 7. $24) \underline{36.6}$ |
| 3. $8) \underline{.2}$ | 8. $18) \underline{.576}$ |
| 4. $13) \underline{3.913}$ | 9. $25) \underline{11.1}$ |
| 5. $12) \underline{48.12}$ | 10. $32) \underline{62.000}$ |

62. Perform the indicated divisions:

$$\frac{1}{25} = 1 \div 25 \quad 25)1.00$$

1. $\frac{1}{4} =$

6. $\frac{7}{125} =$

2. $\frac{1}{8} =$

7. $\frac{100}{82} =$

3. $\frac{4}{5} =$

8. $\frac{180}{75} =$

4. $\frac{4}{50} =$

9. $\frac{5000}{64} =$

5. $\frac{3}{8} =$

10. $\frac{1}{16} =$

63. Give quotients at sight:

1. $932 \div 100$

6. $684 \div 100$

2. $86 \div 1000$

7. $57.6 \div 10$

3. $328 \div 10$

8. $24.3 \div 100$

4. $9 \div 1000$

9. $8.75 \div 10$

5. $48 \div 1000$

10. $932.5 \div 100$

Note. — The pupil should deduce the rule for dividing by 10, 100, 1000.

64. Written Problems.

1. A man had 10.5 yards of cloth, and used 4.125 yards to make a coat. How many yards did he have left?
2. Find the cost of 2.578 acres of land, at \$37 an acre.
3. Find the amount of .87 and 8.7. Find the difference between .906 and 90.6.
4. Write in figures: Seventy-six thousand four hundred nine, and eighty-two thousandths. Nine hundred thousand nine hundred units, and thirty-one hundredths.
5. A franc is 19.3 cents. Find the cost in United States money of goods amounting to 1250 francs.
6. A merchant bought 1800 meters of silk. How many yards did he buy, a meter being 39.37 inches?

MULTIPLICATION OF UNITED STATES MONEY.

68. Find the cost of:

1. 197 barrels of flour, at \$ 5.66 per barrel.
2. 486 bushels of wheat, at \$ 1.04 per bushel.
3. 237 tons of plaster, at \$ 6.72 per ton.
4. 809 tons of hay, at \$ 11.45 per ton.
5. 74 carloads of bran, at \$ 20.62½ per load.
6. 208 sheep, at \$ 4.65 per head.
7. 673 barrels of mackerel, at \$ 10.60 per barrel.
8. 984 bushels of onions, at \$ 1.09 per bushel.
9. 99 pounds of butter, at 24 cents per pound.
10. 208 pounds of coffee, at 28 cents per pound.

69. What will be the cost of 157 pounds of sugar, at 5¢ per pound.

At 5¢ per pound 157 pounds will cost 157 times 5¢. In practice, however, we multiply 157 by the smaller number 5.

Ans. \$ 7.85.

157
5
785

11. 1376 yards of muslin, at 6¾¢.
12. 2084 bushels of corn, at 47½¢.
13. 1864 pounds of beef, at 5½¢.
14. 988 pounds of turkeys, at 13½¢.
15. 296 bushels of potatoes, at 47½¢.
16. 1272 pounds of dried apples, at 2¾¢.
17. 488 pounds of lard, at 10¾¢.
18. 2240 pounds of sugar, at 4½¢.
19. 5176 pounds of wool, at 30¾¢.
20. 4892 bushels of wheat, at 99¾¢.

DIVISION OF UNITED STATES MONEY.

70. Oral Exercises.

How often is 1 quart contained in 1 gallon ? 1 pint in 1 quart ? 2 quarts in 1 gallon ? 1 inch in 1 foot ? 2 inches in 1 foot ? 3 inches in 1 foot ? 4 inches in 1 foot ? 6 inches in 1 foot ? 6 inches in 2 feet ? 8 inches in 2 feet ? 1 ounce in 1 pound ? 1 ounce in 2 pounds ? 4 ounces in 2 pounds ? 1 fourth in 1 half ? 1 third in 1 ?

How often is 1 cent contained in \$1 ? 2 cents in a dollar ? 4 cents in 2 dollars ? 25 cents in 25 dollars ?

$$\$25 = 2500\text{¢} ; 2500\text{¢} \div 25\text{¢} = 100, \text{Ans.}$$

NOTE. — When the divisor is a *concrete* number, *i.e.* a number associated with objects, the dividend must be a like concrete number ; in which case the quotient will be an *abstract* number, *i.e.* a mere number.

3 dollars, 4 coats, 7 apples, are concrete numbers ; 3, 4, 7, are abstract numbers.

When the divisor is *abstract* and the dividend *concrete*, the quotient is *concrete*.

71. Give answers at sight:

- | | |
|--------------------------------------|---------------------------------------|
| 1. $\$4 \div 10\text{¢}$ | 11. $\$1 \div \frac{1}{2}\text{¢}$ |
| 2. $\$5 \div 5\text{¢}$ | 12. $\$3 \div \$\frac{1}{4}$ |
| 3. $\$12 \div 4\text{¢}$ | 13. $\$84 \div 50\text{¢}$ |
| 4. $\$36 \div 6\text{¢}$ | 14. $\$1 \div 16\frac{2}{3}\text{¢}$ |
| 5. $\$63 \div 3\text{¢}$ | 15. $\$16 \div 16\text{¢}$ |
| 6. $\$7 \div 25\text{¢}$ | 16. $\$16 \div 16\frac{2}{3}\text{¢}$ |
| 7. $\$20 \div 33\frac{1}{3}\text{¢}$ | 17. $\$16 \div 33\frac{1}{3}\text{¢}$ |
| 8. $\$36 \div 3\text{¢}$ | 18. $\$16 \div 25\text{¢}$ |
| 9. $\$40 \div 50\text{¢}$ | 19. $\$16 \div 50\text{¢}$ |
| 10. $\$9 \div 10\text{¢}$ | 20. $\$12 \div 20\text{¢}$ |

72. At 36 cents each, how many spellers can be bought for \$27?

$$\begin{array}{r} \$27 = 2700 \text{ cents. Since 1 speller costs 36 cents, the} \\ \text{number of spellers that can be bought for 2700 cents will be} \\ 2700 \div 36 = 75. \end{array}$$

Ans. 75 spellers.

$$\begin{array}{r} 75 \\ 36)2700 \\ -24 \\ \hline 30 \\ -27 \\ \hline 3 \\ -3 \\ \hline 0 \\ \end{array}$$

180

180

73. Written Problems.

1. At \$2.75 per day, how long will it take a man to earn \$110? (11,000 + 275.)

2. How many yards of muslin, at 12 cents per yard, can be bought for \$126?

3. A farmer spent \$140 for sheep at \$5.60 each. How many did he buy?

4. A grocer pays \$74.50 for tea at $\frac{1}{2}$ of a dollar per pound. What is the weight of the tea?

5. When rye is worth 87 cents per bushel, how many bushels can be purchased for \$261?

6. At $12\frac{1}{2}$ cents per pound, how many pounds of meat will cost \$175.25?

7. If 75 spellers cost \$27, what is the price of 1 speller?

If 75 spellers cost \$27, 1 speller will cost $\frac{1}{75}$ of \$27.

$$\begin{array}{r} 75) \$27.00 \\ -24 \\ \hline 30 \\ -27 \\ \hline 3 \\ -3 \\ \hline 0 \\ \end{array}$$

The divisor 75 is an abstract number. The dividend being a concrete number, the quotient will be *concrete*, viz. \$.36.

8. A woman paid \$24 for 36 yards of dress goods. What did she pay per yard?

9. At 6 for a dollar, how many rabbits can be bought for \$87?

10. The cost of 13 houses was \$36,887.50. What was the price of each?

FRACTIONAL PARTS OF A DOLLAR.**SHORT METHODS.**

- 74.** What will be the cost of 16 base-balls at 25 cents each?

At $\$ \frac{1}{4}$ each, 16 base-balls cost 16 quarter-dollars, or $\$4$.

75. Oral Exercises.

At 25 cents per pound, yard, dozen, etc., what will be paid for:

- | | |
|------------------------|----------------------------|
| 1. 32 base-balls ? | 7. 37 dozen lemons ? |
| 2. 52 pounds coffee ? | 8. 25 bushels tomatoes ? |
| 3. 48 straw hats ? | 9. 41 panes of glass ? |
| 4. 84 yards ribbon ? | 10. 33 packages of candy ? |
| 5. 36 second readers ? | 11. 49 Roman candles ? |
| 6. 56 vases ? | 12. 60 bars of soap ? |

76. At 50 cents, give the cost of:

- | | |
|--------------------------|-------------------------|
| 1. 46 pounds tea. | 7. 76 grammars. |
| 2. 28 pairs of scissors. | 8. 57 boxes of pens. |
| 3. 38 penknives. | 9. 49 picture books. |
| 4. 84 third readers. | 10. 83 dolls. |
| 5. 44 pounds candy. | 11. 27 games. |
| 6. 32 caps. | 12. 75 feather dusters. |

77. How many cents in one-eighth of a dollar?

At one-eighth of a dollar each, what will be the cost of 24 bars soap?

At $\$ \frac{1}{8}$ each, 24 bars cost $\$ \frac{1}{8} \times 24$, or $\$3$.

Give the cost of the following at $12\frac{1}{2}$ cents per pound, etc.
(\$ $\frac{1}{4}$):

- | | |
|--------------------|-------------------------------|
| 1. 16 pounds meat. | 5. 80 jars of jelly. |
| 2. 48 dozen eggs. | 6. 96 cans of condensed milk. |
| 3. 72 straw hats. | 7. 104 yards sheeting. |
| 4. 64 gallons oil. | 8. 88 pounds currants. |

78. How many cents in one-third of a dollar?

At one-third of a dollar each, what will be the cost of 12 bottles of cologne?

At \$ $\frac{1}{3}$ each, 12 bottles cost \$ $1\frac{1}{2}$, or \$4.

Give the cost, at $33\frac{1}{3}$ cents per yard, pound, etc., of:

- | | |
|-------------------------|-------------------------|
| 1. 36 yards of ribbon. | 4. 27 bushels of oats. |
| 2. 63 pairs of cuffs. | 5. 54 pecks of walnuts. |
| 3. 48 pounds of butter. | 6. 72 dozen oranges. |

79. How many cents in three-fourths of a dollar?

If sleds cost \$ $\frac{3}{4}$ each, what is paid for 16 sleds?

At \$ $\frac{3}{4}$ each, 16 sleds would cost \$ $12\frac{1}{2}$, or \$4; at \$ $\frac{1}{4}$ each, the cost is 3 times \$4, or \$12.

Give the cost of the following at 75 cents per yard, etc.:

- | | |
|------------------------|------------------------|
| 1. 48 yards silk. | 4. 28 gallons syrup. |
| 2. 24 bushels peaches. | 5. 36 base-balls. |
| 3. 84 pounds tea. | 6. 32 concert tickets. |

80. Find the cost of 13 pairs of gloves at 75 cents per pair.

Since 13 is not exactly divisible by 4, this problem should be handled as follows:

13 pairs at \$ $\frac{1}{4}$ per pair cost \$ $12\frac{1}{4}$, or \$9 $\frac{1}{4}$, or \$9.75.

Give the cost of the following at 75 cents per bushel, etc.:

- | | |
|--------------------------|-------------------------|
| 1. 11 bushels rye. | 4. 7 mats. |
| 2. 15 gallons ice-cream. | 5. 21 bushels potatoes. |
| 3. 9 cloth caps. | 6. 18 pairs of skates. |

81. Parts of a Dollar.

$$6\frac{1}{4} \text{ cents} = \frac{1}{16} \text{ of } \$1$$

$$8\frac{1}{2} \text{ cents} = \frac{1}{12} \text{ of } \$1$$

$$12\frac{1}{2} \text{ cents} = \frac{1}{8} \text{ of } \$1$$

$$16\frac{2}{3} \text{ cents} = \frac{1}{6} \text{ of } \$1$$

$$25 \text{ cents} = \frac{1}{4} \text{ of } \$1$$

$$33\frac{1}{3} \text{ cents} = \frac{1}{3} \text{ of } \$1$$

$$37\frac{1}{2} \text{ cents} = \frac{3}{8} \text{ of } \$1$$

$$50 \text{ cents} = \frac{1}{2} \text{ of } \$1$$

$$62\frac{1}{2} \text{ cents} = \frac{5}{8} \text{ of } \$1$$

$$66\frac{2}{3} \text{ cents} = \frac{2}{3} \text{ of } \$1$$

$$75 \text{ cents} = \frac{3}{4} \text{ of } \$1$$

$$87\frac{1}{2} \text{ cents} = \frac{7}{8} \text{ of } \$1$$

82. Oral Exercises.

Give the cost of 72 articles at:

$$1. 12\frac{1}{2} \text{ cents each.}$$

$$4. 25 \text{ cents each.}$$

$$2. 33\frac{1}{3} \text{ cents each.}$$

$$5. 50 \text{ cents each.}$$

$$3. 16\frac{2}{3} \text{ cents each.}$$

$$6. 37\frac{1}{2} \text{ cents each.}$$

$87\frac{1}{2}$ cents = $\frac{7}{8}$. At $\frac{1}{8}$ each, the cost of 72 articles would be $\$9$;
at $\frac{1}{2}$, $\$27$.

$$7. 62\frac{1}{2} \text{ cents each.}$$

$$9. 66\frac{2}{3} \text{ cents each.}$$

$$8. 87\frac{1}{2} \text{ cents each.}$$

$$10. 75 \text{ cents each.}$$

83. Multiply:

$$1. 6\frac{1}{4} \text{ cents} \times 16$$

$$10. 66\frac{2}{3} \text{ cents} \times 33$$

$$2. 8\frac{1}{2} \text{ cents} \times 24$$

$$11. 75 \text{ cents} \times 128$$

$$3. 12\frac{1}{2} \text{ cents} \times 88$$

$$12. 87\frac{1}{2} \text{ cents} \times 88$$

$$4. 16\frac{2}{3} \text{ cents} \times 54$$

$$13. \$1.33\frac{1}{3} \times 24$$

$$5. 25 \text{ cents} \times 240$$

$$14. \$1.12\frac{1}{2} \times 16$$

$$6. 33\frac{1}{3} \text{ cents} \times 66$$

$$15. \$2.25 \times 12$$

$$7. 50 \text{ cents} \times 186$$

$$16. \$3.75 \times 12$$

$$8. 37\frac{1}{2} \text{ cents} \times 48$$

$$17. \$4.37\frac{1}{2} \times 8$$

$$9. 62\frac{1}{2} \text{ cents} \times 32$$

$$18. \$5.16\frac{2}{3} \times 6$$

84. Find the cost of:

1. 86 neckties, at 50 cents each.
2. Six dozen handkerchiefs, at 25 cents apiece.
3. 32 yards of silk, at \$1.12½ per yard (\$1½).
4. 64 arithmetics, at 75 cents each.
5. 84 geographies, at \$1.25 each (\$1¼).
6. 96 pounds of tea, at 75 cents a pound.
7. 84 pairs of gloves, at \$1.50 per pair.
8. 72 yards of cloth, at \$2.12½ per yard.

85. Written Exercises.

NOTE.—Pupils should be taught to perform operations without placing the numbers under each other. In working examples 1 to 8, one figure is written at a time, beginning at the right. The answers to examples 9 to 12 are found by division, one figure being written at a time. In examples 13 to 20, the cents should be changed to fractions of a dollar.

Write answers.

- | | |
|---------------------------------|-----------------------------|
| 1. 687 pounds, at 4¢. | 11. 933 yards, at 33½¢. |
| 2. 976 yards, at 6¢. | 12. 2504 dolls, at 25¢. |
| 3. 938 coats, at \$7. | 13. 248 pounds, at 75¢. |
| 4. 695 pounds, at 20¢. | 14. 186 pounds, at 66⅔¢. |
| 5. 12 bushels, at \$1.43. | 15. 8 barrels, at \$16.37½. |
| 6. 11 sheep, at \$7.47. | 16. 16 gallons, at \$3.62½. |
| 7. 9 tons, at \$22.75. | 17. 124 bushels, at \$1.50. |
| 8. 13 sacks of salt, at \$1.11. | 18. 96 pounds, at \$1.25. |
| 9. 352 yards, at 12½¢. | 19. 120 gallons at \$2.33½. |
| 10. 1728 hats, at 50¢. | 20. 64 sacks, at \$1.12½. |

86. Oral Exercises.

At 50 cents each, how many penknives can be bought for \$1? For \$2? For \$3? For \$10? For \$20?

At 25 cents each, how many readers can be bought for \$1? For \$2? For \$3? For \$10? For \$20?

At $12\frac{1}{2}$ cents per yard, how many yards can be bought for \$1? For \$2? For \$3? For \$10? For \$20?

At $33\frac{1}{3}$ cents per pound, how many pounds can be bought for \$1? For \$2? For \$3? For \$10? For \$20?

87. At 25 cents each (four for \$1):

1. How many base-balls can be bought for \$9?
2. Straw hats, for \$12?
3. Roman candles, for \$18?
4. Readers, for \$15?
5. Vases, for \$21?
6. Bars of soap, for $3\frac{1}{4}$?
7. Packages of candy, for $4\frac{1}{2}$?
8. Yards of ribbon, for \$5.75?
9. Bushels of tomatoes, for \$10.50?
10. Pounds of coffee, for \$12.75?

88. At 50 cents (two for \$1):

11. Pounds of tea, for \$43?
12. Penknives, for \$20.50?
13. Pounds of candy, for \$94?
14. Third readers, for \$17.50?
15. Caps, for \$21?
16. Grammars, for \$37?

Chapter One.

17. Boxes of pens, for \$72?
18. Dolls, for \$64?
19. Pairs of scissors, for \$19?
20. Feather dusters, for \$26.50?

89. At $12\frac{1}{2}$ cents (eight for \$1):
 21. Gallons of oil, for \$8?
 22. Dozen of eggs, for \$11?
 23. Pounds of meat, for \$21?
 24. Quarts of plums, for $\$1\frac{1}{8}$?
 25. Jars of jelly, for $\$ \frac{3}{4}$?
 26. Yards of sheeting, for $\$.1\frac{1}{2}$?
 27. Cans of milk, for $\$2\frac{1}{4}$?
 28. Pounds of currants, for $\$3.12\frac{1}{2}$?
 29. Whisk brooms, for $\$4.37\frac{1}{2}$?
 30. Collars, for $\$5.62\frac{1}{2}$?

90. At $33\frac{1}{3}$ cents (three for \$1):
 31. Yards of ribbon, for \$6?
 32. Pairs of cuffs, for \$12?
 33. Pounds of butter, for \$18?
 34. Bushels of oats, for \$32?
 35. Pecks of walnuts, for $\$1\frac{1}{2}$?
 36. Dozen of oranges, for $\$1\frac{2}{3}$?
 37. Straw hats, for $\$2.33\frac{1}{3}$?
 38. Dolls, for $\$3.66\frac{2}{3}$?
 39. Penknives, for $\$4.33\frac{1}{3}$?
 40. Pounds of candy, for $\$5.66\frac{2}{3}$?

91. At $16\frac{2}{3}$ cents (six for \$1):

- | | |
|--|--|
| 41. Collars, for \$4? | 46. Quarts, for \$1.16 $\frac{2}{3}$? |
| 42. Pounds, for \$21? | 47. Gallons, for \$1.50? |
| 43. Yards, for \$ $\frac{1}{3}$? | 48. Pecks, for \$2 $\frac{1}{3}$? |
| 44. Ounces, for \$ $\frac{1}{2}$? | 49. Feet, for \$3.33 $\frac{1}{3}$? |
| 45. Packages, for $66\frac{2}{3}$ cents? | 50. Yards, for \$4.66 $\frac{2}{3}$? |

92. Oral Exercises.

Divide at sight:

- | | |
|--|--|
| 51. \$24.50 by 50 cents. | 56. \$18.75 by 25 cents. |
| 52. \$12.25 by 25 cents. | 57. \$11.87 $\frac{1}{2}$ by 12 $\frac{1}{2}$ cents. |
| 53. \$26 by 33 $\frac{1}{3}$ cents. | 58. \$13.33 $\frac{1}{3}$ by 33 $\frac{1}{3}$ cents. |
| 54. \$14.50 by 12 $\frac{1}{2}$ cents. | 59. \$37.50 by 50 cents. |
| 55. \$17 by 16 $\frac{2}{3}$ cents. | 60. \$13.33 $\frac{1}{3}$ by 16 $\frac{2}{3}$ cents. |

DENOMINATE NUMBERS.

93. Learn the following tables:

TIME.

60 seconds (sec.)	= 1 minute (min.)
60 minutes	= 1 hour (hr.)
24 hours	= 1 day (da.)
7 days	= 1 week (wk.)

AVOIRDUPOIS WEIGHT.

16 ounces (oz.)	= 1 pound (lb.)
2000 pounds	= 1 ton (T.)

The hundredweight (100 pounds) is written cwt.

DRY MEASURE.

2 pints (pt.)	= 1 quart (qt.)
8 quarts	= 1 peck (pk.)
4 pecks	= 1 bushel (bu.)

Chapter One.

LIQUID MEASURE.

2 pints (pt.)	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.)

A gill (gl.) is equal to one-fourth of a pint. It is very rarely used.

LINEAR MEASURE.

12 inches (in.)	= 1 foot (ft.)
3 feet	= 1 yard (yd.)
5½ yards	= 1 rod (rd.)
320 rods	= 1 mile (mi.)
1 mi. = 320 rd. = 1760 yd. = 5280 ft. = 63,360 in.	

A furlong is equal to 40 rods, $\frac{1}{2}$ mile.

A hand, used in measuring the height of horses, = 4 in. A knot, used in measuring distances at sea, = 1.15 mi. A fathom, used in measuring the depth of the sea, = 6 ft.

SQUARE MEASURE.

144 square inches (sq. in.)	= 1 square foot (sq. ft.)
9 square feet	= 1 square yard (sq. yd.)
30½ square yards	= 1 square rod (sq. rd.)
160 square rods	= 1 acre (A.)
640 acres	= 1 square mile (sq. mi.)
1 A. = 160 sq. rd. = 4840 sq. yd. = 43,560 sq. ft.	

A section of land is a mile square.

Roofing, flooring, and slating are often estimated by the square, which contains 100 square feet.

94. Written Exercises.

1. How many hours in $7\frac{1}{2}$ days?
2. How many hours in 7 days 12 hours?
3. How many minutes in 2 hours? How many seconds?
4. A man buys 12 bushels and 3 pecks apples at \$1 per bushel. What is the cost?

5. What will be the cost of 3 pecks 7 quarts chestnuts at 8 cents per quart?
6. How many pints are there in 5 gallons of ice-cream?
7. How many half-pints are there in 10 gallons of ice-cream?
8. How many 4-ounce packages can be made from 5 pounds of pepper?
9. A boy pays \$1.50 for 1 gallon and 2 quarts of ice-cream. What is the price per quart?
10. How many gallons of lemonade will be needed to give 96 people $\frac{1}{2}$ pint each?
11. How many seconds in 5 hours?
12. How many hours in 1 week?
13. Change 13 hours and 20 minutes to minutes.
14. Change 15 bushels 4 pecks to pecks.
15. How many ounces in 47 pounds 5 ounces?
16. How many pounds and ounces in 237 ounces?
17. Change 1494 minutes to hours and minutes.
18. Find the number of hours in 6 weeks.
19. Change 60 pounds to the decimal of a hundredweight.
20. How many inches are there in 12 feet 2 inches?
21. How many pounds in $14\frac{1}{4}$ tons?
22. How many pounds in $\frac{5}{8}$ of a ton?
23. What will 400 pounds of coal cost at \$5 per ton?
24. What decimal of a ton is 1500 pounds?
25. How many days and hours in $\frac{1}{3}$ of a week?
26. Find the number of yards in 3 pieces of cloth, each containing 16 yards 2 feet.
27. When coal is \$7.50 per ton, what will be the cost of 3000 pounds?

MEASUREMENTS.**95. Preliminary Exercises.**

Draw a square each side of which is one inch. This is called a square inch. Cut out of paper several one-inch squares.

Draw a rectangle two inches long, one inch wide. How many paper one-inch squares will exactly cover it?

Draw a rectangle three inches long, two inches wide. Divide it into one-inch squares. How many one-inch squares are there in the lower row? How many rows? How many square inches in the rectangle?

How many square inches in a rectangle 6 inches long, 3 inches wide?

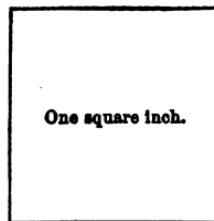
How many square inches in a rectangle 4 inches long, 4 inches wide?

How many square inches are there in a rectangle 12 inches long, 3 inches wide? In a rectangle 1 foot long, 3 inches wide? In a rectangle 1 foot 1 inch long, 4 inches wide?

NOTE. — The foregoing exercises should be accompanied by accurate drawings on paper or on the blackboard, which should lead the pupils to see that the unit in the given examples is the *square inch*. They should be made aware that the number of squares in the lower row corresponds to the length of the rectangle in inches; and that the number of rows corresponds to the width of the rectangle. From this they should deduce the rule :

The number of square inches in the surface of a rectangle is equal to the number of inches in its length taken as many times as there are inches in its width.

This product is called the *area* of the rectangle.



96. The area of a surface is the number of times that it contains another surface, taken as the unit of measurement. Thus, the statement that the area of a surface is 8 square inches means that a square inch is contained in the surface 8 times.

97. The sum of all the sides of a figure is called its perimeter.

98. Written Exercises.

Find the area of each of the following rectangles in square inches. Find the perimeter of each in feet and inches.

- | | |
|---------------------|---------------------------|
| 1. 13 in. by 14 in. | 7. 13 in. by 42 in. |
| 2. 17 in. by 9 in. | 8. 27 in. by 31 in. |
| 3. 18 in. by 7 in. | 9. 18 in. by 22 in. |
| 4. 23 in. by 15 in. | 10. 64 in. by 29 in. |
| 5. 21 in. by 19 in. | 11. 1 ft. by 7 in. |
| 6. 37 in. by 14 in. | 12. 1 ft. 1 in. by 11 in. |

NOTE.—Change each dimension to inches before multiplying.

- | | |
|---------------------------|---------------------------------|
| 13. 1 ft. 3 in. by 12 in. | 17. 2 ft. 6 in. by 1 ft. 3 in. |
| 14. 1 ft. by 1 ft. | 18. 3 ft. 7 in. by 2 ft. 9 in. |
| 15. 1 ft. 4 in. by 1 ft. | 19. 4 ft. 11 in. by 1 ft. 8 in. |
| 16. 2 ft. 6 in. by 1 ft. | 20. 5 ft. 3 in. by 2 ft. 11 in. |

99. Oral Exercises.

How many square feet in a rectangle 2 feet long, 1 foot wide?

How many square feet in a rectangle 6 feet long by 5 feet wide?

How many square feet in a rectangle 9 feet long by 7 feet wide?

NOTE.—The unit in the following examples is the *square foot*.

100. Written Exercises.

Find the area in square feet of each of the following rectangles. Find the perimeter of each in feet.

- | | |
|---------------------|----------------------------------|
| 1. 12 ft. by 14 ft. | 6. 29 ft. by 12 ft. |
| 2. 15 ft. by 17 ft. | 7. $15\frac{1}{2}$ ft. by 12 ft. |
| 3. 19 ft. by 11 ft. | 8. 15 ft. 6 in. by 12 ft. |
| 4. 23 ft. by 15 ft. | 9. $18\frac{3}{4}$ ft. by 16 ft. |
| 5. 18 ft. by 16 ft. | 10. 18 ft. 9 in. by 16 ft. |

Note. — Change the inches to fractions of a foot.

- | | |
|-----------------------------------|-----------------------------------|
| 11. $23\frac{1}{2}$ ft. by 18 ft. | 16. 36 ft. by 23 ft. 5 in. |
| 12. 24 ft. 8 in. by 18 ft. | 17. 13 ft. by $24\frac{1}{4}$ ft. |
| 13. 19 ft. 3 in. by 16 ft. | 18. 13 ft. 4 in. by 24 ft. |
| 14. 24 ft. by 17 ft. 9 in. | 19. 26 ft. 8 in. by 15 ft. |
| 15. 24 ft. by 16 ft. 1 in. | 20. $12\frac{1}{2}$ ft. by 12 ft. |

101. Suggestive Examples.

1. Measure the top of the desk, disregarding fractions of an inch, and calculate the surface in square inches.
2. Measure the blackboard, and find how many square feet in its surface. (Do not include fractions of a foot.)
3. Calculate the number of square inches in a pane of glass in the schoolroom window.
4. Find the number of square feet in the floor of the classroom.
5. Find the number of square feet in the classroom ceiling.
6. Estimate the height of the classroom, and calculate the number of square feet in the front wall.
7. In the rear wall.
8. In the right-hand wall.
9. In the left-hand wall.

102. Written Problems.

SUGGESTION.— When the surface is required in square inches, change each dimension to inches; when required in square feet, express each dimension in feet, or in feet and the fraction of a foot; when required in square yards, etc., express each dimension in yards, etc.

1. How many square feet are there in the surface of a field 125 feet long, 87.5 feet wide?

$$(1 \text{ square foot} \times 125 \times 87.5.)$$

2. A rug is 2 yards long, $1\frac{1}{2}$ yards wide. How many square yards does it contain?

$$(1 \text{ square yard} \times 2 \times 1\frac{1}{2}.)$$

3. How many square yards are there in a strip of carpet 6 yards long, 27 inches ($\frac{3}{4}$ yard) wide?

4. Find the number of square meters in a room 12 meters long, 9.75 meters wide.

5. At 50 cents per square yard, what will be the cost of the oil-cloth needed to cover a floor 18 feet (6 yards) long, 15 feet (5 yards) wide?

6. What will be the cost, at \$1.50 per square yard, of carpeting a room $6\frac{1}{2}$ yards long, 15 feet wide?

7. At 3 cents a square foot, how much must be paid for 10 boards, each 16 feet long, $\frac{1}{2}$ foot wide?

8. A field is 30 rods long and 24 rods wide. How many square rods will it contain after a strip 24 rods long and 2 rods wide is taken from it for a road?

9. How many square yards of plastering will be required for a ceiling 18 feet long, 15 feet wide?

10. If a roll of wall paper is 24 feet long and 18 inches wide, how many square yards does it contain?

BILLS.

103.

CHICAGO, July 31, 1904.

MRS. M. O'DONNELL.

Bought of SEAVER BROTHERS.

	$1\frac{1}{4}$ yd. Plaid	\$ 1.00				
	16 yd. Cambric	.05				
	12 pr. Socks	.25				
	1 Wrapper		1	98		
	4 yd. Silk	.65				
	1 pr. Gloves		2	25		
	2 spools Silk	.08				
						\$

1. Copy the above, filling in the cost of each item and the total.

In these examples, the total cost of each item should be written in its place without any side calculation. Pupils should be drilled in short, direct methods of computation, being required to omit unnecessary figures.

In No. 2, for instance, 64 is multiplied by $5\frac{1}{4}$, as follows:
 $\frac{1}{4}$ of 64 is 8; carry this to the product of 5 and 4, making 28; write 8. 5 times 6 are 30, add 2, making 32. Total, 328.

2. Otto Haas buys of Murphy & Cooper 64 pounds of sugar @ $5\frac{1}{4}\$$; 28 pounds of lard @ $9\frac{1}{4}\$$; 24 pounds of coffee @ $25\frac{1}{4}\$$; 1 barrel flour @ \$5.75; and 12 gallons of molasses @ $25\frac{1}{4}\$$. Make out the bill.

3. Make out a bill for 10 pairs of men's shoes, at \$4.75; 4 pairs of boys' shoes, at $\$1.47\frac{1}{2}$; 6 pairs slippers, at $\$.87\frac{1}{2}$; 9 pairs of girls' shoes, at $\$2.43$; 8 pairs of women's shoes, at $\$3.37\frac{1}{2}$.

4. Make out a bill for $8\frac{1}{2}$ pounds of ham, at $14\frac{1}{2}$ per pound; $3\frac{1}{4}$ pounds of beefsteak, at $20\frac{1}{2}$; 9 pounds of corned beef, at $12\frac{1}{2}$; $10\frac{1}{4}$ pounds of chicken, at $24\frac{1}{2}$; 12 pounds of roast beef, at $18\frac{1}{2}$.

5. Make out a bill for 14 dozen collars, at \$1.50 per dozen; 6 dozen pairs of cuffs, at \$2.75 per dozen pairs; 4 dozen shirts, at \$9 per dozen; 3 dozen ties, at \$2.25 per dozen; 17 dozen pairs of socks, at \$2.10 per dozen pairs.

104. Review Exercises. Approximate Answers.

NOTE. — These drills are intended to lead a pupil to such an examination of his answers to other problems as will prevent him from being satisfied with one that is very far astray.

It is not expected that every pupil will give exactly the same answer. In No. 5, for instance, the cost of 99 yards is asked at \$1.95 per yard. One pupil may consider 100 yards at \$2, or \$200; a second may keep the rate at \$1.95, and say \$195; a third might come still closer; each of such answers, however, should be accepted as an approximation.

1. What will be the cost of $39\frac{1}{2}$ pounds butter at $20\frac{1}{2}$ per pound?

Nearly 40 pounds at $20\frac{1}{2}$. The cost is nearly what? Solve.

2. A man has 4200 pounds of flour which he wishes to put into barrels containing 196 pounds each. About how many barrels will he need?

Each barrel contains nearly how many pounds? Solve.

3. A merchant bought a hogshead of molasses, containing $47\frac{1}{2}$ gallons, at 50 cents per gallon. About how much did it cost?

4. How many lots at \$1975 each can be bought for \$12,000?

5. Sold 3 pieces of cloth, 33 yards to the piece, at \$1.95 per yard. Give the approximate amount of the bill.

Chapter One.

6. $28\frac{5}{8} + 37\frac{1}{2}$ = nearly what?
7. $175\frac{1}{2} + 24\frac{9}{10}$ = nearly what?
8. $18\frac{1}{2} \times 9\frac{7}{8}$ = nearly what?
9. $87\frac{1}{8} - 49\frac{1}{8}$ = nearly what?
10. $4\frac{7}{8} \times 4\frac{8}{9} \times 4\frac{9}{10}$ = nearly what?

105. Oral Review Problems.

1. What will be the cost of 8 pounds of meat at 15 cents per pound?
2. Gave \$1 in payment for a 25-cent ball, and four 10-cent bats. How much change did I receive?
3. At the rate of 3 oranges for 5 cents, what will be the cost of a dozen oranges?
4. A gross is 12 dozen. How many pens in $\frac{1}{4}$ gross?
5. How many inches in 4 yards?
6. At 5 cents per pint, how much would be paid for a bushel of chestnuts?
7. A person used 2 gallons and 3 quarts of milk one week, and 3 gallons and 1 quart the next week. How many gallons are used in the two weeks?
8. Multiply 15 by 5. Take 18 from the product.
9. How many 9's in 3 times 21?
10. 12 times 6 are how many times 8?
11. To 9 times 7 add 10. Take 15 from the sum.
12. One can has in it 4 gallons of milk, and another has in it 6 quarts. How many pints are in both?
13. $27 + 15 + 18 + 25 + 9 = ?$
14. James had half a dollar to spend; he bought 14 cents' worth of candy, and spent the rest of his money for oranges at 4 cents each. How many oranges did he buy?

15. A woman bought 7 pounds of rice at 12¢ a pound, and paid for it with a dollar bill. How much money did she receive in change?
16. A man paid one dollar for a bag of peanuts containing 3 pecks. He sold them at \$0.10 a quart. How much did he gain?
17. Book, 75¢; pencil, 8¢; slate, 15¢ = ?
18. 20 boxes of berries at 15¢ = ?
19. At 6 cents each, how many bananas for \$1? How many cents over?
20. Bought 3 pounds of raisins worth 12 cents a pound; 2 dozen bananas at 25 cents a dozen. I gave the man a dollar bill. How much did he give back?
21. How many hours are there in a week?
22. If John earned 16¢ Monday, 9¢ Tuesday, 20¢ Wednesday, 15¢ Thursday, 8¢ Friday, and 12¢ Saturday, how much did he earn in the whole week?
23. What will 3 bushels of sand cost, at 4¢ a peck?
24. Mrs. Hall divided 84 oranges equally among 14 girls. How many oranges did each girl receive?
25. If you give 24 cents for one thing, and 19 cents for another, what will both things cost?
26. If a quart of milk is worth 7¢, what is the value of two gallons?
27. Find the cost of 60 oranges at 20 cents per dozen.

106. Written Review Problems.

1. A man walks $14\frac{1}{2}$ miles in $4\frac{1}{2}$ hours. How many miles an hour is that?
2. If a milk can holds 23 quarts and 1 pint, how many half-pints does it hold?

3. Bought 87 pounds of tea at 45 cents a pound; sold it at 63 cents a pound. How much was gained?

4. In a school there were 356 girls and 259 boys; if 25 girls and 32 boys leave, how many pupils remain in the school?

5. Which are worth more, 63 cows at \$ 38 apiece, or 56 horses at \$ 75 apiece? How much more?

6. Suppose your mother gave you a 5-dollar bill to buy articles for the Sunday dinner, and you bought 6 lb. of roast beef at 25 cents a lb., 1 pk. spinach at 45 cents, 2 qt. of onions at $12\frac{1}{2}$ cents, 1 doz. oranges at 12 cents, 2 qt. of milk at 7 cents. How much change would you bring home to your mother?

7. If a railway mail clerk earns \$ 800 in a year, how much will he have left after paying his board at the rate of \$ 16 a month?

8. How many pieces of second-class matter (newspapers) are there in 644 pounds, each piece weighing 8 ounces?

9. The postmaster at Norwich made requisition for the following postage stamps: 27 sheets of 1-cent, 97 sheets of 2-cent, 35 sheets of 5-cent, and 17 sheets of 10-cent stamps. What was the money value of these stamps, there being 100 stamps in each sheet?

10. The whole number of pieces of mail matter handled at 212 post-offices was 2,164,517,880. What was the average number of pieces for each office?

11. A merchant pays \$ 30 for 65 vases. He sells 17 of them at 50 cents each, and receives 48 cents each for the others. What is his profit?

12. One boy had 15 marbles, another had 19, a third had 17, a fourth had 13. What was the average number of marbles for each boy?

13. A teacher divided 200 foreign postage stamps among the eight boys of his class. He gave one-fourth of them to the first boy, one-fifth of the remainder to the second boy, and then divided the rest equally among the other six boys. How many did each of the latter receive?
14. If 23 buggies cost \$4025, what are 80 buggies worth?
15. How many gills in 7 quarts and 1 pint?
16. How many bushels in 384 quarts?
17. Change 864 pints to gallons.
18. A farmer exchanged 16 cows, worth \$40 each, for a span of horses. What are the horses worth apiece?
19. A boy bought a bicycle for \$35. He rented it to another boy for 3 months at \$2 a month, and then sold it for \$33.50. Did he gain or lose, and how much?
20. John had 16 marbles, Henry half as many, and Frank as many as both the other boys. How many more marbles had Frank than John?
21. How many quarts in 12 bushels?
22. How many feet of string will be required to go around a room 30 feet long and 25 feet wide?
23. If I buy a bushel of walnuts for \$3, and sell them at 5 cents a pint, how much do I make?
24. Write 83, 47, 69, and 56 in Roman numbers.
25. A man works 9 months, 26 days per month, and receives \$702. What are his daily wages?
26. A merchant buys 136 vases for \$272. If 36 are broken, how much must he charge apiece for the others to gain \$28 on all?

27. On Monday, the receipts of a store are \$180; on Tuesday, \$30 less; on Wednesday, \$110 less than the total of Monday and Tuesday. What are the receipts for the three days?

28. The yearly rent of a house is \$480. What is the rent for 2 years 4 months?

29. A mechanic works 300 days per year, at \$4 per day. If his daily expenses for 365 days average \$3, how much money does he save each year?

30. A woman pays \$5.20 for 3 pounds of tea and 56 pounds of sugar. What is the price per pound of the sugar, if the tea costs 80¢ per pound?

31. A man had \$7500. He paid $\frac{2}{3}$ of it for a house, \$575.60 for repairs, and \$387.75 for furniture. How much money had he left?

32. How much hay will be required to feed 18 horses a month of 30 days, if each horse receives 15 pounds a day?

33. A person pays a debt of \$576, giving 40 ten-dollar bills, 30 two-dollar bills, 6 one-dollar bills, and the remainder in five-dollar bills. How many of the last did he give?

34. A drover buys 64 sheep for \$400. He sells $\frac{1}{4}$ of them at \$7 each, and the remainder at \$8 each. What is his profit?

35. A merchant sells 56 yards of cloth for \$84, gaining \$14. What did it cost him per yard?

36. A package of coffee, costing 60 cents, was sold for 75 cents, the profit on each pound being 5 cents. What was the selling price per pound?

37. How many yards of cloth, at \$1.75 per yard, can be bought for \$105?

38. A tailor buys a piece of cloth for \$50. From it he makes 4 pairs of trousers, which he sells at \$7 per pair, and 4 coats, for each of which he receives \$15. Thread, buttons, lining, etc., cost him \$16. How much does he get for his labor?

39. A man sold a certain number of papers for 50 cents. If he had sold nine more, he would have received 95 cents. How many papers did he sell?

40. How long is a post which is $5\frac{1}{2}$ feet above water, one-half of its length in the water, and one-fourth of its length in the mud? (Make a diagram.)

41. Eight pounds of black tea costing 35¢ per pound are mixed with twelve pounds of green tea costing 50¢ per pound. What is the cost of 20 pounds of the mixed tea?

42. How many bushels and pecks are there in 1442 pounds of corn weighing 56 pounds per bushel?

43. How is division proved?

44. Multiply by 208 the quotient of $(169,668 \div 36)$.

45. Add seventy-two dollars, eleven cents; fifteen dollars, nine cents; eighty-seven cents; three hundred fifty dollars; and one dollar, four cents.

46. Which is greater and how much?

$$486 \times 29 \text{ or } 26,845 - 19,976.$$

47. Write in Roman numerals 1905, 1775, and 560.

48. If a railway mail clerk spends ten cents a day for street-car fare, how much will he spend in six months of 30 days each?

49. Add nine thousand eleven, seventy thousand forty-four, five hundred thousand four hundred ten, fifty-four thousand twenty-one.

50. Multiply \$40.25 by 96.

51. From \$300,000 take \$7050.75.
52. How many days will 36 bushels of oats last 12 horses, if each horse eats 12 quarts a day?
53. If a barrel of flour is worth \$4.50, how many barrels can be bought for \$441? How much will all the flour weigh if each barrel holds 196 pounds?
54. Suppose your slate is 12 inches long, 9 inches wide, and 15 inches across diagonally. How long a string is needed to go around the outside and along the diagonal? Make a diagram to explain your work.
55. The total cost of the Union Pacific railroad, which is 1819 miles long, was \$157,092,478. What was the average cost per mile?
56. An officer who was paid \$3.50 a day stayed in the service until he had earned \$143.50. How many days had he worked?
57. A cargo of potatoes was discharged in tubs containing 250 pounds each, which were filled 1785 times. A bushel of potatoes weighs 60 pounds. How many bushels were landed?
58. How long will it take 50 clerks to count \$1,500,000 in silver coin, one-half of which is in half-dollars and the other half in quarter-dollars, each clerk counting at the rate of fifty pieces a minute? Express the answer in hours.
59. Write in figures one million one thousand one dollars and one cent.
60. Multiply 657,934 by 3209.
61. The War Department expended \$1765.25 for mucilage at \$5.75 a dozen quarts. How many quarts were purchased?

CHAPTER II.

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FACTORS AND MULTIPLES.

107. The *factors* of a number are the integers whose product makes the number.

NOTE. — An integer is any whole number.

2 and 3 are factors of 6.

2, 3, and 5 are factors of 30.

108. A number that contains another number an exact number of times is a *multiple* of that number.

24 is a multiple of 12; 36, 48, etc., are also multiples of 12.

30 is a multiple of 2, 3, 5, 6, 10, 15.

109. Preliminary Exercises.

1. 95 is a multiple of what two numbers?
2. Give the two factors of 51.
3. What number is a multiple of both 8 and 6?
4. Mention another number that is a multiple of both 8 and 6.
5. Find the smallest number that can be exactly divided by 8 and 12.
6. Give the two factors of 91.
7. 57 is a multiple of what two numbers?
8. What is the smallest number that can be exactly divided by 4, 6, and 8?

PRIME NUMBERS.**110. A number that has no factors is a *prime number*.**

NOTE.—1 is not considered a factor.

1, 2, 3, 5, 7, etc., are prime numbers.

111. 1. Name the prime numbers between 10 and 20.
2. Between 20 and 30. 4. Between 50 and 70.
3. Between 30 and 50. 5. Between 70 and 100.

112. Oral Exercises.

Give the prime factors, commencing with the smallest.

- | | | | |
|-------|--------|--------|--------|
| 1. 15 | 6. 40 | 11. 64 | 16. 80 |
| 2. 16 | 7. 48 | 12. 72 | 17. 81 |
| 3. 24 | 8. 54 | 13. 74 | 18. 82 |
| 4. 32 | 9. 56 | 14. 76 | 19. 84 |
| 5. 36 | 10. 60 | 15. 77 | 20. 85 |

113. Written Exercises.

1. Find the prime factors of 180.

Divide 180 by its smallest prime factor, 2. Divide the quotient 90 by its smallest prime factor, 2. Divide 45 by its smallest prime factor, 3. Divide 15 by its smallest prime factor, 3. The quotient 5 is a prime number.

The prime factors of 180 are 2, 2, 3, 3, 5, *Ans.*

$$\begin{array}{r} 2 \mid 180 \\ 2 \mid 90 \\ 3 \mid 45 \\ 3 \mid 15 \\ \hline & 5 \end{array}$$

- | | | | |
|-------|--------|---------|----------|
| 2. 86 | 7. 92 | 12. 100 | 17. 576 |
| 3. 87 | 8. 93 | 13. 120 | 18. 840 |
| 4. 88 | 9. 94 | 14. 210 | 19. 1152 |
| 5. 90 | 10. 95 | 15. 240 | 20. 1728 |
| 6. 91 | 11. 96 | 16. 360 | 21. 2016 |

GREATEST COMMON DIVISOR.

114. A *common factor* of two or more numbers is a number that will divide each of them without remainder.

The largest number that is a factor of two or more numbers is called the *greatest common divisor*.

115. Oral Exercises.

Find the greatest common divisor of:

- | | |
|--------------|---------------|
| 1. 27 and 48 | 6. 34 and 51 |
| 2. 25 and 35 | 7. 32 and 48 |
| 3. 36 and 54 | 8. 45 and 75 |
| 4. 26 and 39 | 9. 40 and 65 |
| 5. 42 and 63 | 10. 54 and 69 |

LOWEST TERMS.

116. How can you tell that a number is divisible by 2? By 5?

A number is divisible by 3 when the sum of its digits (figures) is divisible by 3; it is divisible by 9 when the sum of its digits is divisible by 9.

A number is divisible by 4 when the number expressed by its last two figures is divisible by 4.

When is a number divisible by 25?

A fraction is reduced to *lowest terms* by dividing the numerator and the denominator by their greatest common divisor.

117. Written Exercises.

1. Reduce $\frac{138}{300}$ to its lowest terms.

A look at both terms shows that 3 is a common factor. This reduces the fraction to $\frac{41}{100}$. 41 is a prime number, and is not a factor of 100, so that $\frac{41}{100}$ cannot be reduced to lower terms.

2. Reduce $\frac{432}{1000}$ to its lowest terms.

$$4 + 3 + 2 = 9; \quad 6 + 2 + 1 = 9.$$

Since the sum of the digits of each term is divisible by 9, this number is a common factor, and reduces the fraction to $\frac{48}{100}$, etc.

3. Reduce $\frac{438}{1000}$ to its lowest terms.

5 is clearly a common factor, etc.

Reduce to lowest terms:

4. $\frac{144}{88}$

8. $\frac{275}{850}$

12. $\frac{512}{640}$

5. $\frac{375}{600}$

9. $\frac{28}{112}$

13. $\frac{324}{432}$

6. $\frac{144}{216}$

10. $\frac{88}{98}$

14. $\frac{576}{640}$

7. $\frac{182}{178}$

11. $\frac{51}{69}$

15. $\frac{184}{204}$

118. Reduce to its lowest terms $\frac{169}{1001}$.

In this example, it is not easy to ascertain by inspection any number that will divide both terms. In such cases, the greatest common

divisor is found by dividing the denominator by the numerator. The remainder is divided into the numerator, and each subsequent remainder is divided into the corresponding divisor until there is no longer a remainder. This last divisor is the *greatest common divisor* of the two numbers.

The numerator, 169, is contained in the denominator, 1001, 5 times with 156 remainder. This remainder is contained in the numerator, 169, one time with 13 remainder. This remainder is contained in the previous divisor, 156, 12 times with no remainder.

$$\begin{array}{r} 5 \\ 169) \overline{1001} \\ 845 \quad 1 \\ \hline 156) \overline{169} \\ 156 \quad 12 \\ \hline 13) \overline{156} \\ 13 \\ \hline 13 \end{array}$$

13 is the greatest common divisor.

$$\frac{169 + 13}{1001 + 13} = \frac{13}{77} \text{ lowest terms.}$$

Note. — In reducing fractions to lowest terms, the method of finding the greatest common divisor given above should not be resorted to if it is possible to get along without it.

119. Written Exercises.

Reduce to lowest terms:

1. $\frac{47}{55}$

5. $\frac{217}{248}$

9. $\frac{51}{68}$

2. $\frac{111}{222}$

6. $\frac{78}{221}$

10. $\frac{119}{187}$

3. $\frac{49}{51}$

7. $\frac{68}{153}$

11. $\frac{115}{181}$

4. $\frac{67}{82}$

8. $\frac{77}{182}$

12. $\frac{118}{240}$

SUGGESTION. — Do not waste time in finding the greatest common divisor.

13. $\frac{25}{100}$

17. $\frac{875}{1000}$

21. $\frac{875}{1000}$

14. $\frac{40}{100}$

18. $\frac{86}{100}$

22. $\frac{8125}{10000}$

15. $\frac{25}{1000}$

19. $\frac{625}{1000}$

23. $\frac{625}{1000}$

16. $\frac{125}{1000}$

20. $\frac{845}{1000}$

24. $\frac{845}{1000}$

LEAST COMMON MULTIPLE.

120. The smallest number that is a multiple of two or more numbers is called the *least common multiple* of such numbers.

121. Oral Exercises.

Give the least common multiple of:

- | | |
|------------------|-----------------------|
| 1. 16 and 24 | 6. 2, 3, 5, 9, 10 |
| 2. 12 and 15 | 7. 2, 3, 5, 6, 9, 10 |
| 3. 3, 9, 11 | 8. 3, 6, 9, 12, 4, 18 |
| 4. 4, 12, 16 | 9. 2, 7, 14, 3, 9 |
| 5. 2, 3, 4, 5, 6 | 10. 5, 10, 20, 25, 50 |

122. Written Exercises.

Find the least common multiple of 3, 9, 7, 14, 6, 14, 2, 12.

3 is stricken out since it is a factor of 6, which is one of the numbers. 7 is a factor of 14, one 14 is stricken out. 6 is a factor of 12. 2 is a factor of 12. The least common multiple of the remaining numbers, 9, 14, and 12, is to be found.

Divide these numbers by a prime number that is exactly contained in any two of them, bringing down the numbers that are not multiples of the divisor.

Taking 2 as a divisor, bring down 9, and write quotients 7 and 6.

3 being a factor of two of the three numbers, 9, 7, 6, is taken as the next divisor. 3 is written as a quotient, 7 is brought down, 2 is a quotient.

As there is no factor common to any two of the numbers, 8, 7, 2, we find the least common multiple by multiplying together the two divisors and these three numbers.

$$2 \times 3 \times 3 \times 7 \times 2 = 252 \text{ L. C. M.}$$

123. Find the L. C. M. of:

- | | |
|----------------------|--------------------------------|
| 1. 4, 6, 3, 5, 8, 20 | 2. 9, 15, 15, 4, 4, 12, 25 |
| Strike out 4, 3, 5. | Strike out one 15 and two 4's. |

3. 2, 3, 5, 7, 5, 14, 10, 12, 24
4. 2, 3, 5, 6, 8, 10, 15, 16, 80
5. 20, 30, 40, 50
6. 2, 3, 4, 6, 8, 12, 16, 24
7. 24, 12, 5, 3, 10, 18
8. 11, 3, 7, 77, 33
9. 18, 5, 9, 40, 16
10. 10, 12, 15, 21

ADDITION AND SUBTRACTION OF FRACTIONS.

124. In adding or subtracting fractions, they must be reduced to a common denominator.

The *least common denominator* is the least common multiple of the denominators.

125. Add the fractions, $\frac{3}{4}$, $\frac{11}{10}$, $\frac{5}{6}$, $\frac{17}{30}$, $\frac{23}{45}$, $\frac{7}{12}$.

2 |	4	20	6	30	45	12	
	10		15	45	6		Strike out 4 and 6.
	5		45	3			Strike out 15, a factor of 45.

Strike out 5 and 3, factors of 45.

$$\text{L. C. M.} = 2 \times 2 \times 45 = 180.$$

$\frac{3}{4}$	180
$\frac{11}{10}$	135
$\frac{5}{6}$	99
$\frac{17}{30}$	150
$\frac{23}{45}$	102
$\frac{7}{12}$	92
	105
	3148

Ans. $3\frac{148}{180} = 3\frac{37}{30}$.

To add, reduce the fractions to a common denominator, add the numerators, and place the sum over the common denominator. Reduce if possible.

To subtract, reduce the fractions to a common denominator, subtract the numerators, and place the difference over the common denominator. Reduce if possible.

NOTE. — In the following examples, determine the least common denominator by *inspection*, if possible.

126. Add:

- | | |
|--|--|
| 1. $8\frac{4}{7}, 5\frac{1}{4}, 3\frac{1}{8}$ | 6. $\frac{2}{5}, \frac{3}{5}, \frac{1}{10}, \frac{3}{10}, \frac{1}{5}$ |
| 2. $45\frac{3}{5}, 20\frac{1}{2}, 8\frac{1}{4}, 9\frac{1}{8}$ | 7. $63\frac{1}{10}, 3\frac{2}{5}, 2\frac{1}{5}, 5\frac{1}{5}, 7\frac{7}{15}$ |
| 3. $32\frac{1}{4}, 19\frac{1}{8}, 6\frac{1}{2}, 8\frac{1}{2}\frac{1}{8}$ | 8. $5\frac{1}{12}, 18\frac{1}{10}, 3\frac{1}{5}, 7\frac{1}{8}, 8\frac{1}{4}$ |
| 4. $2\frac{1}{2}, 20, 3\frac{2}{3}, \frac{5}{12}, 5\frac{1}{8}$ | 9. $4\frac{3}{10}, 7\frac{8}{10}, 84, 6\frac{7}{1000}, \frac{23}{100}$ |
| 5. $8\frac{1}{5}, 45\frac{5}{8}, 2\frac{1}{2}\frac{1}{6}, 4\frac{1}{2}, 4\frac{1}{10}$ | 10. $17\frac{9}{1000}, \frac{27}{100}, 6\frac{8}{10}, 1\frac{5}{100}, \frac{3}{100}$ |

11. Work No. 9 as an example in decimals.

12. Work No. 10 as an example in decimals.

127. Subtract:

- | | |
|--|--|
| 13. $65\frac{11}{24} - 57\frac{5}{16}$ | 18. $251\frac{8}{21} - 271\frac{7}{8}$ |
| 14. $18\frac{1}{40} - 9\frac{2}{8}$ | 19. $755\frac{1}{8} - 283\frac{3}{4}$ |
| 15. $100\frac{4}{11} - 15\frac{1}{12}$ | 20. $123\frac{1}{4} - 80\frac{1}{2}$ |
| 16. $102\frac{3}{16} - 27\frac{1}{16}$ | 21. $100\frac{4}{10} - 89\frac{7}{1000}$ |
| 17. $208\frac{11}{12} - 128\frac{1}{10}$ | 22. $67\frac{1}{10} - 58\frac{1}{1000}$ |

23. Work No. 21 as an example in decimals.

24. Work No. 22 as an example in decimals.

128. Perform the operations indicated:

$$25. \frac{21+5}{25+5} - \frac{21}{25}$$

$$26. \frac{21}{25} - \frac{21-5}{25-5}$$

$$27. (37\frac{1}{8} - 11\frac{1}{8}) - (28\frac{7}{15} - 19\frac{1}{12})$$

$$28. 14\frac{5}{8} - 8\frac{1}{2} - 3\frac{1}{8} + 4\frac{1}{4}$$

$$29. (8\frac{1}{16} + 6\frac{1}{8}) - (8\frac{1}{16} - 6\frac{1}{8})$$

30. $4\frac{3}{4} \times 16 \times 8\frac{7}{8}$
 31. $(2\frac{2}{3} + 5\frac{1}{6}) + (1\frac{1}{3} + 2\frac{1}{2} + 3\frac{1}{3})$
 32. $(8\frac{1}{2} + 4\frac{1}{4}) + (2\frac{1}{2} + 1\frac{1}{4})$
 33. $(3\frac{5}{12} \times 36) \times 8\frac{7}{8}$
 34. $4\frac{3}{8} + 3\frac{1}{2} - 6\frac{5}{7} + 17\frac{1}{3} - 9\frac{1}{4}$

129. Oral Problems.

1. A person travelling from New York to Albany (140 miles apart) has gone $102\frac{3}{4}$ miles. How much farther has he to go?
2. There are 196 pounds of flour in a barrel. How many pounds in $\frac{1}{4}$ barrel?
3. How many fourths in $24\frac{3}{4}$?
4. Reduce $\frac{48}{60}$ to lowest terms.
5. Change $1\frac{19}{20}$ to a mixed number.
6. Add $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{4}$.
7. From a chest of tea containing $45\frac{1}{4}$ pounds, $14\frac{1}{4}$ pounds are sold. How many pounds remain?
8. From $\frac{1}{2}$ of a dollar take $10\frac{2}{3}$ cents.
9. How many cents in $\frac{1}{4} + \frac{1}{5} + \frac{3}{10}$ of a dollar?
10. A farmer has $60\frac{1}{4}$ acres of pasture and $20\frac{1}{2}$ acres of woodland. How many acres in both?
11. Considering the circumference of a circle as $3\frac{1}{4}$ times its diameter, find the circumference of a circle whose diameter is 8 feet.
12. Mary is $12\frac{7}{12}$ years old; Jane is $3\frac{1}{2}$ years older. How old is Jane in years and months?
13. In a year and a half William will be 7 years 2 months old. How old is he now?

14. What number multiplied by 3 equals 231?
15. What number between 7 and 12 is a prime number?
16. A boy received 9 marks in arithmetic, 8 in penmanship, and 7 in reading. What was his average mark?
17. $\frac{4}{7}$ of a class consists of boys. How many girls in the class, if it contains 49 pupils?
18. When July 1 falls upon Tuesday, what will be the date of the third Tuesday of July?
19. If July 1 falls upon Thursday, upon what day will the first of August fall?
20. A man bought $20\frac{1}{2}$ pounds of sugar; he sold $10\frac{3}{4}$ pounds at one time and $6\frac{1}{2}$ pounds at another. How much had he left?
21. If 3 quarts 1 pint of oil cost 7 cents, what will 1 gallon 1 quart cost?
22. How much will have to be paid for 7 cows at \$50 each, and 4 horses at \$150 each?
23. $\frac{4}{5} =$ how many hundredths?
24. What are the two factors of 87?
25. Find the G. C. D. of 36 and 54.
26. If eggs are sold at the rate of 21 for 25 cents, how much will be paid for $5\frac{1}{4}$ dozen?

SUGGESTION.—Every member of the class should be required to solve one of the foregoing examples as a sight problem, first reading it from the book, and then giving the answer. No time should be wasted in "analyzing" the problems, unless some pupil desires the explanation of one that he does not understand.

At another time, the teacher should read, say, five or ten problems, requiring the answer to each to be written, at a given signal, and the pencil laid down before the next is read. No alteration of an answer should be permitted.

130. Written Problems.

1. A horse travelled $48\frac{8}{10}$ miles in one day, $56\frac{1}{4}$ the next, $40\frac{1}{2}$ the third, and $45\frac{27}{40}$ the fourth. How far did he travel in all?
2. To the sum of $6\frac{1}{4}$ and $19\frac{1}{2}$ add their difference.
3. From a bin containing $25\frac{5}{8}$ bushels of grain there were taken out $5\frac{3}{4}$ bushels at one time and $6\frac{1}{2}$ at another. How much remained?
4. A merchant sold 4 pieces of cloth containing $27\frac{1}{2}$ yards, $26\frac{3}{4}$ yards, $29\frac{5}{8}$ yards, and $28\frac{1}{4}$ yards, respectively. How much did he receive for the cloth at 96 cents per yard?
5. Reduce $\frac{18}{22}$ to lowest terms.
6. A man has $8\frac{5}{16}$ bushels of peanuts. He puts them into bags holding $\frac{1}{4}$ bushel. How many bags does he fill?
7. A 160-acre farm consists of five fields; the first contains $17\frac{1}{2}$ acres, the second $29\frac{1}{4}$ acres, the third $35\frac{7}{20}$ acres, the fourth $22\frac{8}{5}$ acres. How many acres are there in the fifth field?
8. From a piece of silk that contained $28\frac{1}{2}$ yards, there were sold $2\frac{1}{2}$ yards, $6\frac{1}{4}$ yards, and $13\frac{3}{4}$ yards. Find the value of the remainder at \$1.20 per yard.
9. Three pieces of cloth bought at \$2 per yard cost \$150. The first piece measures $23\frac{1}{2}$ yards, the second measures $30\frac{1}{4}$ yards. How many yards in the third piece?
10. What part of a person's income remains after he spends $\frac{1}{3}$, $\frac{1}{5}$, and $\frac{1}{7}$ of it?
11. A boy loses $\frac{1}{2}$ of his marbles, and he gives away $\frac{1}{4}$ of them. If he has 17 marbles left, how many had he at first?
12. A dealer sells $1\frac{1}{4}$ gross, $3\frac{1}{2}$ gross, and $8\frac{1}{2}$ gross of lead pencils at 36 cents per dozen. How much does he receive for all?
 $1 \text{ gross} = 12 \text{ dozen.}$

Chapter Two.

13. There are four towns, A, B, C, and D, on a certain railroad running east and west. A is $41\frac{1}{2}$ miles west of C; D is $39\frac{1}{4}$ miles east of B; B is $22\frac{1}{2}$ miles west of C. How many miles from A to D? Make a diagram.

CANCELLATION.

131. Preliminary Exercises.

1. Divide 64 by 16. The quotient is 4.
2. Divide $\frac{1}{2}$ of 64 by $\frac{1}{2}$ of 16; i.e. $32 \div 8$.
3. Divide $\frac{1}{4}$ of 64 by $\frac{1}{4}$ of 16; i.e. $16 \div 4$.
4. Divide $\frac{1}{8}$ of 64 by $\frac{1}{8}$ of 16; i.e. $8 \div 2$.

In each case the quotient is 4.

In example 2 we took out of the dividend 64 the factor 2, making the new dividend 32; and we took out of 16 the same factor, making the new divisor 8.

In example 3 we took what factor out of the divisor and the dividend? What common factor was taken out in example 4?

Rejecting the same factor from the divisor and the dividend does not change the quotient.

In reducing $\frac{1}{2}$ to $\frac{1}{4}$ what factor common to the numerator and the denominator of the first fraction is rejected? Is the value of the first fraction altered by this rejection?

Cancellation is the striking out of common factors from the divisor and the dividend.

132. Oral Exercises.

- | | | | |
|------------------------------|------------------------------|-------------------------------|-------------------------------|
| 1. $\frac{36 \times 14}{9}$ | 5. $\frac{42 \times 23}{21}$ | 9. $\frac{67 \times 36}{18}$ | 13. $\frac{83 \times 36}{12}$ |
| 2. $\frac{37}{8} \times 16$ | 6. $\frac{4}{23} \times 46$ | 10. $\frac{32}{41} \times 82$ | 14. $\frac{15}{16} \times 48$ |
| 3. $12 \times \frac{43}{24}$ | 7. $32 \times \frac{67}{96}$ | 11. $4 \times \frac{93}{12}$ | 15. $15 \times \frac{87}{30}$ |
| 4. $\frac{25 \times 18}{36}$ | 8. $\frac{33 \times 12}{99}$ | 12. $\frac{89 \times 13}{26}$ | 16. $\frac{44 \times 17}{34}$ |

RATIO.**133. Preliminary Exercises.**

1. If oranges are worth 28 cents a dozen, what will be the cost of 3 oranges?
2. What part of a dozen is 3?
3. What is the ratio of 3 to 12?

Ratio is the relation between two like numbers. It is found by dividing the first by the second.

4. What is the ratio of 12 to 16?
5. If 16 apples cost a certain sum, what part of this sum should be paid for a dozen apples?

134. Written Exercise.

1. If 17 horses cost \$4000, what will be the cost of 51 horses at the same price for each?

Since the ratio between 51 and 17 is $\frac{3}{1}$, or 3, 51 horses will cost 3 times \$4000, or \$12,000.

2. If 15 eggs cost 25 cents, what will 10 dozen cost?

The ratio of 10 dozen eggs to 15 eggs is $\frac{10 \times 12}{15}$.

Multiply 25 cents by $\frac{10 \times 12}{15}$.

In this case, 15 is not contained in any number above the line. We divide 15 and 10 by 5, canceling them and writing quotients 3 and 2 alongside.

3 is contained in 12 4 times; so we cancel 3 and 12.

Our answer now is $25 \text{ cents} \times 2 \times 4 = 200 \text{ cents}$, or \$2.

$$\begin{array}{r} & 2 & 4 \\ & \cancel{15} & \\ \underline{25 \times 10 \times 12} & & \\ & 15 & \\ & & 3 \end{array}$$

3. Eighteen men can do a piece of work in 26 days. How long will it take 13 men to do the same work?

Thirteen men will do the work in $\frac{13}{18}$ of the time required by 18 men.

4. Seventeen barrels of flour, 196 pounds each, were put into bags holding 49 pounds each. How many bags of flour were put up?
5. At the rate of 23 cents for 7 pounds, how much would be paid for 91 pounds of flour?
6. A bank pays \$4 interest a year on every \$100. How much interest will be paid for 3 years on \$650?
7. At \$7.50 per thousand for bricks, what must I pay for 63,200 bricks?
8. If flour is \$6 per barrel (196 lb.), what must be paid for a 49-pound bag?
9. A grocer buys 84 dozen eggs, and sells them at the rate of 21 eggs for 25 cents. What does he receive for them?
10. A miller buys 9840 pounds of wheat at 90 cents per bushel of 60 pounds. How much does he pay for it?
11. What will be the cost of 64 sheep, if 18 cost \$198?
12. If 18 men can do a piece of work in 42 days, how long will it take 21 men to do the same work?
13. What will be the cost of 66 dozen pens at 42 cents per gross of 12 dozen?
14. A certain quantity of hay feeds 15 horses 56 days. How long will it feed 14 horses?
15. A merchant bought 9 pieces of cloth, each containing 24 yards, for \$189. What was the price per yard?

MULTIPLICATION OF FRACTIONS

135. Preliminary Exercises.

What is $\frac{1}{2}$ of 2 fifths? Of 4 sevenths? Of 6 elevenths?

What is $\frac{1}{2}$ of $\frac{1}{2}$? Of $\frac{1}{3}$? Of $\frac{1}{4}$? Of $\frac{1}{5}$? Show by diagram.

What is $\frac{1}{2}$ of $\frac{2}{3}$? Of $\frac{2}{4}$? Of $\frac{2}{5}$? Of $\frac{2}{6}$?

What is $\frac{1}{3}$ of $\frac{1}{2}$? $\frac{2}{3}$ of $\frac{1}{2}$? $\frac{3}{3}$ of $\frac{1}{2}$?

What is $\frac{1}{2}$ of $\frac{3}{4}$? $\frac{2}{3}$ of $\frac{3}{4}$? $\frac{3}{4}$ of $\frac{3}{4}$?

What is $\frac{1}{2}$ of $\frac{1}{3}$? $\frac{1}{2}$ of $\frac{2}{3}$? $\frac{2}{3}$ of $\frac{1}{3}$? $\frac{2}{3}$ of $\frac{2}{3}$?

What is the half of $1\frac{1}{2}$? Of $2\frac{1}{2}$? Of $3\frac{1}{2}$? Of $4\frac{1}{2}$?

What is one-third of $1\frac{1}{2}$? $\frac{2}{3}$ of $1\frac{1}{2}$? $\frac{1}{2}$ of $2\frac{1}{2}$? $\frac{2}{3}$ of $2\frac{1}{2}$?

136. Written Exercises.

- Multiply $\frac{1}{2}$ by $\frac{2}{3}$.

This means to find $\frac{1}{2}$ of $\frac{2}{3}$.

Since $\frac{1}{2}$ of $\frac{1}{2} = \frac{1}{15}$, $\frac{1}{2}$ of $\frac{2}{3} = \frac{1}{15}$, and $\frac{2}{3}$ of $\frac{1}{2} = \frac{1}{15}$, or $\frac{1}{2} \times \frac{2}{3} = \frac{1}{15}$.

One fraction is multiplied by another by placing the product of the numerators over the product of the denominators in the form of a fraction.

NOTE. — Cancel when possible.

- Multiply $\frac{2}{5}$ by $\frac{9}{10}$.

$$\frac{1}{2} \text{ of } \frac{9}{10} = \frac{9}{10} \quad \frac{2}{5} \text{ of } \frac{9}{10} = 2 \text{ times } \frac{9}{10} = \frac{9}{5}$$

$$\begin{array}{l} \text{Cancel 2 and 10, writing 5 under 10. Cancel} \\ 3 \text{ and 9, writing 3 above 9.} \end{array} \quad \frac{2}{3} \times \frac{9}{10} = \frac{3}{5}$$

Show by a diagram that 2 times $\frac{1}{10}$ is $\frac{1}{5}$.

- Multiply $12\frac{1}{7}$ by $3\frac{4}{15}$.

Reduce the mixed numbers to improper fractions.

$$\frac{17}{7} \times \frac{49}{15} = \frac{119}{3} = 39\frac{2}{3}$$

- Multiply 117 by $3\frac{2}{9}$.

The multiplication of an integer by a mixed number, or of a mixed number by an integer, can be considered as multiplication of fractions, the integer being written as an improper fraction with 1 for the denominator.

$$\frac{13}{1} \times \frac{29}{9} = 377$$

137. Multiply:

- | | |
|--|--|
| 1. $\frac{2}{3}$ by 96 | 16. $\frac{5}{14} \times 8\frac{3}{4}$ |
| 2. 128 by $\frac{3}{4}$ | 17. $3\frac{1}{2}$ by $12\frac{1}{2}$ |
| 3. $\frac{4}{5}$ by $\frac{3}{7}$ | 18. $\frac{7}{8} \times 4\frac{1}{2}\frac{1}{8}$ |
| 4. $\frac{5}{6}$ by $\frac{7}{8}$ | 19. $\frac{5}{7}$ by $\frac{3}{5}$ by $\frac{1}{12}$ |
| 5. $\frac{2}{3}$ by $\frac{5}{6}$ | 20. $\frac{2}{3}\frac{1}{6}$ of $\frac{2}{3}\frac{2}{7}$ of $\frac{4}{5}$ |
| 6. $3\frac{5}{12}$ by 72 | 21. $\frac{1}{2}\frac{1}{2} \times \frac{2}{3} \times \frac{9}{22}$ |
| 7. $24\frac{3}{4}$ by 18 | 22. $\frac{1}{3}\frac{2}{3}$ of $\frac{1}{4}\frac{1}{3}$ of $\frac{3}{4}\frac{1}{4}$ |
| 8. $69\frac{3}{4}$ by 32 | 23. $\frac{7}{8}$ of $65\frac{3}{4}$ |
| 9. $111\frac{4}{5}$ by 28 | 24. $\frac{3}{4}$ of $55\frac{5}{8}$ |
| 10. 67 by $\frac{15}{7}$ | 25. $6\frac{1}{2} \times 7\frac{3}{8}$ |
| 11. $2\frac{1}{2}$ by $3\frac{3}{5}$ | 26. $4\frac{1}{4} \times 5\frac{1}{6}$ |
| 12. $\frac{9}{16} \times 2\frac{3}{8}$ | 27. $\frac{2}{3}$ of $4\frac{1}{2} \times 3\frac{3}{8}$ |
| 13. $17\frac{1}{4}$ by $6\frac{1}{3}$ | 28. $\frac{5}{7}$ of $3\frac{1}{3} \times 4\frac{1}{11}$ |
| 14. $6\frac{1}{8} \times 4$ | 29. $1\frac{1}{2} \times 2\frac{1}{3} \times 3\frac{1}{4}$ |
| 15. $4\frac{1}{4}$ by $8\frac{3}{4}$ | 30. $2\frac{1}{2} \times 2\frac{1}{3} \times 2\frac{1}{4}$ |

138. Perform the indicated operations:

NOTE.— $\frac{1}{2}$ of $3\frac{1}{2}$ is the same as $\frac{1}{2} \times 3\frac{1}{2}$, or $3\frac{1}{2} \times \frac{1}{2}$.

- | | |
|---|--|
| 1. $\frac{1}{3}$ of $(3\frac{1}{2} + 6\frac{1}{4})$ | 6. $(8\frac{3}{4} \times 21) - (\frac{1}{2}$ of $15\frac{3}{4})$ |
| 2. $(3\frac{1}{2} - 2\frac{1}{2}) \times \frac{5}{6}$ | 7. $5\frac{1}{2} + 6\frac{2}{3} + 7\frac{1}{4}$ |
| 3. $\frac{1}{4}$ of $(5\frac{1}{3} - 3\frac{2}{3})$ | 8. $18\frac{5}{8} - 3\frac{2}{3} - 7\frac{1}{6}$ |
| 4. $(24\frac{1}{3} + 16\frac{1}{2}) + 8$ | 9. $\frac{2}{3}$ of $\frac{3}{4}$ of $(3\frac{1}{2} + 1\frac{1}{4})$ |
| 5. $(3\frac{1}{4} + 2\frac{1}{2}) \times (3\frac{1}{4} - 2\frac{1}{2})$ | 10. $(18\frac{1}{3} - 6\frac{2}{3}) + 11$ |

139. Oral Exercises.

- Sold a house lot for \$30, which was $\frac{2}{3}$ of what it cost me. What was the cost of the lot?
- A man can mow $6\frac{2}{3}$ acres of grass in a day. How much can he mow in 6 days?

3. A man bought 15 bushels of corn for $7\frac{1}{2}$ dollars. How much did a bushel cost?

4. A boy is 18 years old and his age is $\frac{2}{3}$ of the age of his father. How old is his father?

5. Cloth is worth $\frac{3}{10}$ of a dollar a yard. What is $\frac{5}{6}$ of a yard worth?

6. At the rate of 5 cents for $\frac{1}{4}$ of a pie, for how many pies will a man receive \$1.60?

7. What would $\frac{1}{6}$ of a yard of carpet cost at $\frac{3}{4}$ of a dollar a yard?

8. I had $\frac{5}{12}$ of a pound of candy and gave away $\frac{2}{3}$ of it. What part of a pound did I give away?

9. What will 15 yards of ribbon cost at $6\frac{2}{3}$ cents a yard?

10. What will $2\frac{1}{2}$ gallons of ice-cream cost at $1\frac{1}{4}$ dollars a gallon?

140. Written Exercises.

1. A man worked 6 days at $2\frac{3}{4}$ dollars per day, his son 5 days at $1\frac{1}{4}$ dollars, his daughter 4 days at $\frac{1}{6}$ of a dollar. What were their total earnings?

2. A merchant bought a piece of cloth for $28\frac{1}{2}$ dollars and was obliged to sell it for $\frac{2}{3}$ of what it cost him. How much did he lose?

3. A hotel in one month used 31 pounds of coffee and $7\frac{2}{3}$ times as much sugar. How much sugar was used?

4. A man gave $124\frac{5}{6}$ acres of land to his two sons, giving $\frac{2}{3}$ of it to the elder and $\frac{1}{3}$ to the younger. How many acres did each receive?

5. If it requires $21\frac{1}{4}$ days for a man to dig a ditch, what part can he dig in 15 days?

6. If a bird can fly $10\frac{1}{4}$ miles in $\frac{5}{6}$ of an hour, how far can it fly in $2\frac{1}{2}$ hours?
7. What would be the cost of a side of veal containing 52 pounds at $9\frac{1}{2}$ cents a pound?
8. What will 16 pairs of shoes cost at $\$3\frac{1}{2}$ a pair?
9. A man who owed $\$7825$ failed and could pay only $\frac{2}{5}$ of his debts. How much could he pay?
10. I bought a house and lot and made a payment of $\$4500$, which was $\frac{5}{6}$ of the cost. What was the cost of the property?

DIVISION OF FRACTIONS.

141. Preliminary Exercises.

1. If 3 yards of calico cost 18 cents, what is the price per yard?

$18\text{¢} + 3$, or $\frac{1}{3}$ of 18¢ . The latter may be written $18\text{¢} \times \frac{1}{3}$.

2. If $1\frac{1}{2}$ yards of dress goods cost 18¢ , what is the price per yard?

$18\text{¢} + 1\frac{1}{2}$, or $18\text{¢} + \frac{3}{2}$.

To divide 18 by $\frac{3}{2}$, we can change 18 to halves and proceed as follows: $\frac{18}{2} + \frac{3}{2} = 36 + 3$.

The following are the steps: 18 is multiplied by 2 , and the product is divided by 3 , or $\frac{18 \times 2}{3}$, which is the same as $18 \times \frac{2}{3}$.

That is, $18 + \frac{3}{2} = 18 \times \frac{2}{3}$.

3. If 3 yards of dress goods are required to make a waist, how many waists can be made out of 18 yards?

The number of waists = $18 + 3 = \frac{1}{3}$ of $18 = 18 \times \frac{1}{3}$.

That is, $18 + \frac{3}{2} = 18 \times \frac{2}{3}$.

4. If an apron requires $1\frac{1}{2}$ yards of material, how many aprons can be made out of 18 yards?

The number of aprons = $18 + 1\frac{1}{2} = 18 + \frac{3}{2} = 18 \times \frac{2}{3}$.

5. If it takes three-quarters of a pound of flour to make a loaf of bread, how many loaves can be made with 18 pounds of flour?

The number of loaves = $18 + \frac{3}{4} = 18 \times \frac{4}{3}$.

6. At three-quarters of a dollar each, how many dolls can be bought for a dollar and a half?

$$\$1\frac{1}{2} + \$\frac{3}{4} = \$\frac{3}{2} + \$\frac{3}{4} = \$\frac{3}{2} \times \frac{4}{3}.$$

To divide by $\frac{3}{4}$ (examples 1 and 8), we multiply by $\frac{4}{3}$.

To divide by $\frac{3}{2}$ (examples 2 and 4), we multiply by $\frac{2}{3}$.

To divide by $\frac{1}{2}$ (examples 5 and 6), we multiply by 2 .

To divide by a fraction, multiply by the divisor inverted.

7. Divide 8 by $\frac{4}{5}$.

$$8 + \frac{4}{5} = 8 \times \frac{5}{4} = 10, \text{ Ans.}$$

8. Divide $\frac{2}{7}$ by 10.

$$\frac{2}{7} + 10 = \frac{2}{7} \times \frac{1}{10} = \frac{1}{35}, \text{ Ans.}$$

9. Divide $6\frac{3}{4}$ by 9.

$$6\frac{3}{4} + 9 = \frac{1}{9} \text{ of } 27 = \frac{3}{4}, \text{ Ans.}$$

142. Divide:

1. $\frac{2}{3} + 4$

4. $\frac{4}{11} + \frac{3}{11}$

7. $\frac{4}{15} + \frac{1}{15}$

9. $\frac{4}{5} + 3\frac{3}{5}$

2. $\frac{5}{7} + 10$

5. $\frac{1}{15} + \frac{4}{15}$

8. $3\frac{3}{5} + \frac{4}{5}$

10. $\frac{1}{6} + \frac{2}{3}$

3. $1\frac{3}{4} + 5$

6. $\frac{8}{11} + \frac{4}{11}$

143. Written Exercises.

1. Divide $1\frac{9}{16}$ by $2\frac{3}{20}$.

$$\frac{9}{16} + \frac{3}{20} = \frac{9}{16} \times \frac{20}{3} = \frac{15}{4} = 3\frac{3}{4}$$

2. Divide $15\frac{4}{11}$ by 13.

Changing the mixed number to an improper fraction, we have,

$$15\frac{4}{11} + 13 = \frac{169}{11} + \frac{13}{1} = \frac{169}{11} \times \frac{1}{13} = \frac{13}{11} = 1\frac{2}{11}$$

Divide:

3. $\frac{3}{20} \div \frac{9}{16}$

4. $5 \div 1\frac{3}{4}$

5. $8\frac{1}{2} \div 11$

6. $4\frac{5}{11} \div 17$

7. $24\frac{1}{3} \div 20$

8. $\frac{4}{11} \div 6\frac{2}{7}$

9. $\frac{11}{24} \div 8\frac{5}{24}$

10. $\frac{4}{5} \div \frac{5}{6}$

11. $\frac{8}{15} \div \frac{1}{7}$

12. $\frac{9}{11} \div \frac{8}{16}$

13. $8\frac{7}{16} + 3\frac{4}{5}$

14. $9\frac{7}{6} + 3\frac{4}{5}$

15. $18\frac{1}{2} \div 11\frac{3}{8}$

16. $23\frac{1}{2} \div 6\frac{5}{7}$

NOTE. — The pupil should prove his answers to each of the foregoing examples by multiplying the quotient by the divisor. If his answer is correct, this product will equal the dividend.

144. Perform operations indicated:

17. $(3\frac{2}{3} \times 4\frac{1}{2}) - 10\frac{1}{4}$

18. $(13\frac{2}{3} - 7\frac{2}{3}) \times \frac{3}{4}$

19. $(20 \times \frac{3}{4}) \div \frac{7}{8}$

20. $(20 \div \frac{5}{6}) \times \frac{3}{4}$

21. $20 \div (\frac{7}{8} \times \frac{3}{4})$

22. $(20 + \frac{5}{6}) \div \frac{3}{4}$

23. $(14\frac{3}{4} \times 7) - (9 \times 10\frac{7}{8})$

24. $(1\frac{5}{8} \times \frac{2}{3}\frac{1}{3}) + (4\frac{1}{2} \times 6\frac{7}{8})$

25. $34\frac{5}{8} - 17\frac{5}{8} + 20\frac{1}{4}$

26. $18\frac{5}{8} + 24\frac{7}{12} - 36\frac{1}{8}$

27. $\frac{5\frac{1}{2} \times 9 \times 7\frac{1}{3}}{4\frac{1}{2} \times \frac{5}{6}}$

28. $\frac{5\frac{1}{2} \times 7\frac{1}{3} \times 3\frac{1}{4} \times 6\frac{1}{4}}{2\frac{1}{4} \times 4\frac{1}{2} \times 31}$

145. Oral Problems.

Give analysis of each :

- If base-balls are worth $\frac{3}{4}$ of a dollar each, what will be the cost of 16 base-balls?

NOTE. — The pupil is frequently at a loss to determine whether a given problem in fractions involves multiplication or division. In such a case, he should substitute for the fraction a whole number to ascertain the proper operation. While in example 1 a pupil would analyze without hesitation : "If base-balls are worth $\frac{3}{4}$ each, 16 balls would cost 16 times $\frac{3}{4}$," he might stumble at No. 2. By reading the problem, "Paid a certain sum for base-balls at $\frac{3}{4}$ each," he would see that the number of balls is ascertained by division. His analysis would then be, "If base-balls are $\frac{3}{4}$ each, I can buy as

many balls as there are $\frac{3}{4}$ in \$12." The work would be $12 + \frac{3}{4} = 12 \times \frac{7}{4}$. He could complete the solution by finding $\frac{1}{4}$ of 12, taking $\frac{1}{4}$ of 12 as 3, etc. Another method of solving this problem mentally, is to change the price to a whole number and to make a corresponding change in the cost. "Paid 4 times \$12 for base-balls at 4 times $\frac{3}{4}$ each; i.e. \$48 for balls at \$3 each."

2. Paid \$12 for base-balls, at $\frac{3}{4}$ of a dollar each. How many were bought?
3. What is the cost of 2 feet of ribbon at 30 cents per yard?
4. Find how much a yard of ribbon is worth, if $\frac{1}{3}$ yard costs 20 cents.
5. If it takes $\frac{1}{4}$ yard of material to make a child's waist, how many can be made from a piece containing 24 yards?
6. If 18 jackets require 24 yards of cloth, how much is needed for 1 jacket?
7. A man had 60 acres of land. How many acres had he left after selling $\frac{1}{2}$ of his land?
8. After spending $\frac{1}{3}$ of his money, a person had \$26 remaining. How much money had he at first?
9. When tea is \$.50 per pound, how much can be bought for \$.75?
10. If tea is worth $\frac{1}{4}$ of a dollar per pound, how much can be bought for $\frac{1}{2}$ of a dollar?
11. When silk is selling at \$.75 per yard, how much can be bought for one-fourth of a dollar?
12. Find the cost of a gallon of milk at the rate of 9 cents for 3 pints.
13. $\frac{3}{4}$ of a gallon of milk costs 9 cents. What is the price per gallon?
14. $\frac{3}{4}$ of what number is 12?
15. 1 yard and 1 foot of wire cost 16 cents. How much must be paid for a yard?

146. Written Problems.

1. How much does a man earn in a day if he earns $45\frac{1}{2}$ dollars in a month of 26 working days?
2. When flour is $5\frac{1}{4}$ dollars per barrel, how many barrels can be bought for 294 dollars?
3. If coffee is $37\frac{1}{2}$ cents per pound, how many pounds can be bought for 60 dollars?
4. A man divided 16 dollars among some boys, giving to each $1\frac{1}{8}$ dollars. How many boys received a share?
5. Paid $38\frac{1}{2}$ dollars for $6\frac{7}{8}$ cords of wood. What was the price per cord?
6. How many steps will it take to walk 2640 feet, each step being $2\frac{1}{2}$ feet in length?
7. A man put $40\frac{1}{2}$ bushels of barley into bags holding $1\frac{1}{8}$ bushels. How many bags were required?
8. In $2\frac{1}{4}$ acres of land, how many building lots of $\frac{1}{8}$ of an acre?
9. If $\frac{1}{8}$ of a farm is worth \$8000, what is $\frac{5}{8}$ of it worth?
10. The product of two factors is $9\frac{7}{12}$; one factor is $3\frac{5}{8}$. What is the other?

SPECIAL DRILLS—REVIEW.

147. Give sums at sight:

- | | | |
|-------------------|--------------------|-------------------|
| 1. $59 + 75 =$ | $59 + 70 + 5 =$ | |
| 2. $48 + 63 =$ | 5. $88 + 22 =$ | 8. $66 + 56 =$ |
| 3. $69 + 47 =$ | 6. $94 + 38 =$ | 9. $29 + 94 =$ |
| 4. $67 + 83 =$ | 7. $61 + 39 =$ | 10. $65 + 86 =$ |
| 11. $560 + 390 =$ | $560 + 300 + 90 =$ | |
| 12. $270 + 280 =$ | 14. $430 + 480 =$ | 16. $420 + 280 =$ |
| 13. $640 + 260 =$ | 15. $250 + 390 =$ | 17. $780 + 260 =$ |

18. $225 + 154 = 225 + 150 + 4 =$

19. $315 + 421$

21. $540 + 355$

23. $172 + 304$

20. $437 + 260$

22. $248 + 131$

24. $517 + 329$

148. Give remainders at sight:

1. $134 - 75 = 134 - 70 - 5 =$

2. $150 - 83$

5. $124 - 89$

8. $100 - 61$

3. $132 - 94$

6. $112 - 56$

9. $124 - 35$

4. $122 - 56$

7. $180 - 89$

10. $132 - 38$

11. $750 - 290 = 750 - 200 - 90 =$

12. $510 - 220$

14. $820 - 560$

16. $910 - 550$

13. $630 - 380$

15. $730 - 440$

17. $380 - 290$

18. $279 - 154 = 279 - 150 - 4 =$

19. $386 - 263$

21. $668 - 325$

23. $386 - 123$

20. $457 - 237$

22. $279 - 125$

24. $721 - 468$

149. Give products at sight:

1. $49 \times 4 = 4$ forties + 4 nines.

2. 47×3 3. 48×4 4. 43×5 5. 46×6 6. 38×7

7. $123 \times 3 = 3$ times one twenty three = three sixty nine.

8. 431×2 10. 332×3 12. 232×3

9. 122×4 11. 242×2 13. 31×24

14. $47 \times 25 = \frac{1}{4}$ of 47 hundred = $11\frac{1}{4}$ hundred = 1175.

15. $25 \times 38 = 38 \times 25 = \frac{1}{4}$ of 38 hundred = $9\frac{1}{4}$ hundred.

16. 32×25 18. 44×25 20. 49×25

17. 25×33 19. 25×45 21. 63×25

150. Give quotients at sight:

1. $925 + 25 = 9\frac{1}{4}$ hundred + $\frac{1}{4}$ hundred = $9\frac{1}{4} + \frac{1}{4} = 9\frac{1}{2} \times 4$.

2. $875 + 25$ 4. $725 + 25$ 6. $575 + 25$

3. $625 + 25$ 5. $450 + 25$ 7. $350 + 25$

151. Oral Problems.

1. Find the cost of a pound of tea at 75 cents, and a piece of ham at 56 cents.
2. A farmer sold 58 sheep from his flock of 121 sheep. How many remained?
3. What will be paid for 8 pounds of coffee at 35¢ per pound?
4. A laborer received \$4.88 for four days' work. How much did he earn per day?
5. At \$40 each, how many cows can be purchased for \$2000?
6. Bought 20 pounds of sugar at 5¢ per pound, and $2\frac{1}{2}$ pounds of butter at 30¢. What was the amount of my bill?
7. A piece of cloth measuring $31\frac{1}{2}$ yards was divided into 2 equal parts. Find the length of each.
8. How many weeks in a year of 366 days?
9. If I pay 25 cents for 3 pounds of cherries, how many pounds can I buy for \$1.25?
10. Find the cost of a bushel and a peck of peanuts at the rate of 5 cents per quart.
11. A farmer had 164 acres of land. How much had he left after selling 87 acres?
12. Find the total number of pounds in 3 tubs of butter weighing respectively 25 pounds, 34 pounds, and 36 pounds.
13. At 60¢ per pound, how much tea can be bought for \$5.85?
14. A drover paid \$219 for oxen, at an average price of \$73. How many did he buy?
15. What will be the cost of 20 bushels of wheat at \$1.04 $\frac{1}{2}$ per bushel?
16. At 24¢ per pound, how many ounces of butter can be bought for 18¢?

17. A woman pays \$540 per year for a house. What is the rent per month?
18. How many weeks in 294 days?
19. At 72¢ per yard, what will be the cost of 2 ft. 11 in. of lace?
20. How much does a grocer receive for a barrel of flour, 196 pounds, retailed at 3 cents per pound?
21. If 47 men can do a piece of work in 4 days, how long will it take 1 man to do the same work?
22. Find the cost of 36 acres of land at \$25 per acre.
23. If it takes $3\frac{1}{2}$ yards of cloth to make a coat, how many coats can be made from $24\frac{1}{2}$ yards?
24. How much will be paid for 84 yards of silk at $\$1\frac{1}{4}$ per yard?
25. If a certain quantity of provisions will last one man 215 days, how long will it last 43 men?
26. How many square yards are there in a rectangular field 36 yards long and 25 yards wide?

152. Written Exercises.

1. What is the sum of 94,625; 215; 5172; 819,365; 121?
2. Bought 172 acres of land for \$860. What was that an acre?
3. In a classroom there are 54 pupils; each pupil spent \$2.75 for books this year. How much money was spent for books by the whole class?
4. By the census of 1890, Massachusetts had a population of 2,238,943; in 1900, it had a population of 2,805,346. What was the gain?
5. How many boxes of strawberries at \$.15 a box can I get for \$1.20?

6. What is a proper fraction? An improper fraction? Define numerator, denominator, a mixed number.

7. Add $\frac{1}{3}$, $\frac{5}{6}$, $\frac{2}{3}$, and $\frac{1}{2}$.

8. If 7 pairs of shoes cost \$12 $\frac{1}{2}$, how much will one pair cost?

9. $\frac{4}{7} + \frac{2}{14} + \frac{8}{21} = ?$

10. What is the product of $\frac{9}{10}$, $\frac{20}{3}$, $\frac{1}{5}$, and $\frac{45}{8}$?

11. $8\frac{1}{5} \times 7\frac{2}{5} = ?$

12. Paid $\frac{3}{4}$ of a dollar for potatoes, $\frac{4}{5}$ of a dollar for apples, and $\frac{9}{10}$ of a dollar for sugar. How much did I pay for all?

13. Divide $2\frac{1}{4}$ by $1\frac{1}{2}$.

14. Find the difference between $4\frac{3}{4}$ and $3\frac{1}{2}$.

15. $\frac{80}{8} + \frac{25}{40} + \frac{5}{16} = ?$

MULTIPLICATION OF DECIMALS.

153. Oral Problems.

1. When the French franc is worth 19.3 cents, what is the value of the 20-franc piece in United States money?

2. What is the equivalent of 10 German marks, the mark being quoted at $23\frac{8}{10}$ cents?

3. A man paid 100 pounds sterling for a piano. Find the cost in U. S. money at \$4.8665 per pound sterling.

NOTE. — \$4.8665 may be read 4 dollars 86 cents 6 mills and 5 tenths of a mill, a mill being one-tenth of a cent.

4. A meter contains 39.37 inches. How many inches in 100 meters?

5. One kilogram = 2.2046 pounds. What is the equivalent of 1000 kilograms, in pounds?

NOTE. — .2046 is read 2046 ten-thousandths.

6. How many square yards are there in a piece of ground 40 yards long and 12.5 yards wide?

7. How many ounces in 2.5 pounds?
8. Change .75 hour to minutes.
9. Find the perimeter of a square, each side of which measures 10.25 feet.

154. Written Exercises.

1. Multiply 38.4 by 6.37.

Place the units' figure (6) of the multiplier under the last figure (4) of the multiplicand. 6 times 4 tenths = 24 tenths = 2.4; write .4 under the multiplier 6, and carry 2; etc. Next multiply by .3, or $\frac{3}{10}$. $\frac{1}{10} \times \frac{3}{10} = \frac{3}{100}$, or .12. Write 2 in the hundredths' place, and carry 1 tenth; etc. Multiply finally by .07, or $\frac{7}{100}$. $\frac{1}{100} \times \frac{7}{100} = \frac{7}{1000}$, or .028. Write 8 in the thousandths' place, etc.

$$\begin{array}{r} 38.4 \\ \times 6.37 \\ \hline 230.4 \\ 11.52 \\ \hline 244.608 \end{array}$$

Ans. 244.608.

NOTE. — By writing the units' figure of the multiplier under the last figure of the multiplicand, and by taking care to place the right-hand figure of each partial product under the corresponding figure of the multiplier, the decimal points in the partial products and the total will naturally fall under the decimal point in the multiplicand.

2. Multiply 12.34 by 56.7.

$\begin{array}{r} 12.34 \\ \times 56.7 \\ \hline 617.0 \\ 74.04 \\ 8.638 \\ \hline 699.678 \end{array}$	While pupils should occasionally begin to multiply by the left-hand figure (5) of the multiplier, some may prefer to begin with the right-hand figure (7). It will be noted that the number of decimal places in the product equals the sum of those in the multiplier and the multiplicand.	$\begin{array}{r} 12.34 \\ \times 56.7 \\ \hline 8.638 \\ 74.04 \\ 617.0 \\ \hline 699.678 \end{array}$
---	--	---

Multiply as in whole numbers, and from the right of the product point off as many decimal places as there are decimal places in both factors.

155. Multiply:

1. 32×2.5
2. 3.2×25
3. 6.4×4.5
4. 7.2×3.75

5. 12.8×5.7
 6. 9.6×1.125
 7. 34.9×2.34

8. 5.625×8.4
 9. 1.875×12.8
 10. 42.36×2.95

NOTE.—The pupil should correct any error he may make in placing the decimal point by estimating the approximate answer. The answer to example 8, for instance, is more than 2 times 32 and less than 3 times 32. In example 8, it is more than 4 sixes and less than 5 sevens.

11. 1.75×64
 12. 8.375×40
 13. 24.5×18.2
 14. $9.6 \times 12\frac{1}{2}$
 15. 7.43×3.6
 16. 18.4×20.25
 17. 11.16×42.40
 18. $66.6 \times 3.3\frac{1}{2}$
 19. 6.24×1.75
 20. 400.04×39.25

156. Oral Problems.

1. I owned 40 acres of land and sold .25 of it. How many acres did I sell?
2. A boy bought 15 hens, which was .6 of what he already had. How many had he at first?
3. A lawyer charged me .11 of the money for collecting \$100. How many dollars did he charge?
4. If I earn \$8 in a week, how much can I earn in 7.5 weeks?
5. .75 of a class of 44 were promoted. How many were not promoted?
6. What is the surface of a table 4 feet wide and 6.25 feet long?
7. .5 of a yard is how many feet? How many inches?
8. A man bought 3.5 yards of cloth at \$5 a yard. What was the price?
9. 25 miles is .5 of the distance between two cities. What is the distance?
10. In a box were 100 oranges; .08 of them became spoiled. How many sound ones were left?

157. Written Problems.

1. How many yards are there in 25 pieces of carpeting if each piece contains 32.75 yards?
2. A mill uses 95.6 tons of coal per day. How many tons will it use in 42.25 days?
3. A cubic foot of water weighs 62.5 pounds; ice is .92 as heavy as water. What is the weight of a cubic foot of ice?
4. I bought 3 loads of wood, the first containing 1.04 cords, the second 1.05 cords, and the third .946 cord. What did it cost me at \$4.50 a cord?
5. A gallon of water weighs 8.33 pounds. What is the weight of a gallon of milk which is 1.03 times as heavy as water?
6. A wheel in making one revolution travels 15.03 feet. How far will it travel in 25 revolutions?
7. A ship sails 18.54 miles in an hour. How far will she sail in 15.5 hours?
8. Find the cost of concreting a cellar 24.5 feet long by 14.25 feet wide, at 30 cents per square foot.
9. A quantity of provisions will last 25 men 12.75 days. How long will it last one man?
10. Two men start from the same place and travel in opposite directions, one at the rate of 3.85 miles per hour, and the other at the rate of 4.12 miles per hour. How far apart will they be at the end of 13 hours? Make a diagram.

DIVISION OF DECIMALS.**158. Divide 42 by 2.1.**

Changing the decimal fraction in the divisor to a common fraction, we have

$$42 + 2\frac{1}{10} = 42 + \frac{21}{10} = 42 \times \frac{10}{10} = \frac{420}{10}.$$

$$42 + 2.1 = 420 + 21.$$

Note. — When we change the divisor 2.1 to 21, we have multiplied it by 10, and the same change must be made in the dividend.

Make the divisor a whole number, and make a corresponding change in the number of decimal places in the dividend. This reduces the numbers to the same denomination. If necessary to complete the operation, ciphers may be annexed to the dividend. The number of decimal places in the quotient is equal to the number in the dividend as changed.

159. Written Exercises.

Divide:

- | | |
|---------------------------|-------------------------|
| 1. $80 \div 2.5$ | 9. $50 \div .25$ |
| 2. $8 \div 2.5$ | 10. $72 \div .5$ |
| 3. $840 \div 1.2$ | 11. $960 \div .03$ |
| 4. $36 \div \frac{9}{10}$ | 12. $.847 \div .007$ |
| 5. $36 \div .9$ | 13. $27 \div .002$ |
| 6. $12.6 \div 6.3$ | 14. $10 \div .8$ |
| 7. $48 \div 15$ | 15. $1.263 \div .03$ |
| 8. $18.36 \div .6$ | 16. $19.63 \div .013$ • |

17. Divide 196.3 by .013.

Remove the decimal point in the divisor three places to the right, and make a corresponding change in the dividend, adding two ciphers.

To show where the decimal point originally belonged, draw a cancellation mark through it, instead of erasing it.

When the divisor is thus made a whole number, the decimal point in the quotient will be placed under (or over) the new decimal point in the dividend.

$$1.736 \div 16$$

$$17.36 \div .16$$

$$.01736 \div 1.6$$

$$\begin{array}{r} .1085 \text{ Ans.} \\ 16)1.7360 \end{array} \qquad \begin{array}{r} 108.5 \text{ Ans.} \\ ,16.)17,36.0 \end{array} \qquad \begin{array}{r} .01085 \text{ Ans.} \\ 1,6,)0.17360 \end{array}$$

- | | |
|-------------------|---------------------|
| 18. $.504 + .024$ | 26. $392 + 3.2$ |
| 19. $5.04 + .24$ | 27. $48 + 3000$ |
| 20. $50.4 + 2.4$ | 28. $92 + .23$ |
| 21. $504 + 24$ | 29. $.875 + 125$ |
| 22. $168 + .7$ | 30. $381.17 + 8.11$ |
| 23. $36 + .12$ | 31. $.624 + 9.75$ |
| 24. $.875 + .25$ | 32. $48.195 + 3.57$ |
| 25. $123.6 + .01$ | 33. $829.31 + .019$ |

160. Divide 381.6 by 95.032.

$$\begin{array}{r}
 4.015 + \\
 95,032) 381,600.000 \\
 \underline{380128} \\
 147200 \\
 \underline{95032} \\
 521680
 \end{array}$$

NOTE. — The sign (+) after the last figure of the quotient indicates that there is a remainder.

161. Divide, carrying out the quotient to 3 places of decimals:

- | | |
|-------------------|----------------------|
| 34. $31 + 13$ | 37. $7.049 + 1.6$ |
| 35. $4.5 + 17$ | 38. $81.22 + 3.275$ |
| 36. $920.07 + 46$ | 39. $246.3 + 93.473$ |

162. Write answers at sight:

NOTE. — To multiply .042 by 100, the decimal point is moved two places to the right; i.e. $.042 \times 100 = 4.2$; $.042 \times 200 = 4.2 \times 2 = 8.4$.

- | | | |
|----------------------|--------------------|-----------------------|
| 1. $.042 \times 200$ | 5. $40 \times .7$ | 9. $.121 \times 4000$ |
| 2. $.13 \times 300$ | 6. $25 \times .8$ | 10. $.061 \times 500$ |
| 3. $.014 \times 50$ | 7. $234 \times .2$ | 11. $.03 \times 1000$ |
| 4. 8.1×60 | 8. $.73 \times 30$ | 12. $.012 \times 700$ |

NOTE. — Remember that $369 + 1000 = \frac{369}{1000} = 369$ thousandths = .369. To divide 369 by 3000, therefore, divide .369 by 3.

- | | | |
|---------------------|----------------------|---------------------|
| 13. $369 \div 3000$ | 17. $2460 \div 3000$ | 21. $4.68 \div 20$ |
| 14. $219 \div 300$ | 18. $196 \div 4000$ | 22. $30.5 \div 500$ |
| 15. $48.6 \div 60$ | 19. $6 \div 500$ | 23. $18.8 \div 200$ |
| 16. $1.89 \div 90$ | 20. $27.9 \div 300$ | 24. $248 \div 4000$ |

163. Written Exercises.

1. $1728 \div 1200$	2. $172.8 \div 1200$	3. $1.728 \div 1200$
$12\cancel{0}0)17.28$;	$12\cancel{0}0)1.72$; 8	$12\cancel{0}0).01$; 728
.144 Ans.	.144 Ans.	.00144 Ans.

Cancel the ciphers in the divisor, and remove the decimal point in the dividend a corresponding number of places to the left, prefixing ciphers if necessary.

164. Divide:

- | | |
|----------------------|-----------------------|
| 1. $2436 \div 3000$ | 7. $45 \div 800$ |
| 2. $136.5 \div 1300$ | 8. $25.2 \div 240$ |
| 3. $84.8 \div 80$ | 9. $345.6 \div 1200$ |
| 4. $100.1 \div 700$ | 10. $4004 \div 110$ |
| 5. $1 \div 40$ | 11. $5.28 \div 60$ |
| 6. $2.2 \div 50$ | 12. $907.5 \div 1500$ |

165. Oral Problems.

- I cut 8.72 yards of cloth into 8 equal pieces. How long was each piece?
- I divided .75 of a pound of candy equally among 3 girls. What part of a pound did each receive?
- I divided .5 of a pound of cherries among 4 children. What part of a pound did each receive?
- 49 rods is .7 of the distance round a field. How many rods of fence will enclose the field?
- 24 yards of matting cover .8 of my floor. How many yards more must I buy?

6. 40 pounds are .4 of my weight. What do I weigh?
 7. I spent 2.5 dollars, which was .5 of what I had. How much had I?
 8. 36 square inches are .25 of a square foot. How many square inches in a square foot?
 9. A collector receives .05 of all the money he collects. How much did he collect to earn \$15?
 10. At 75 cents each, how many chairs can be bought for \$12?
- 166. Written Problems.**
1. If 35.84 cubic feet of water weigh a ton, what will be the weight of 2458.6 cubic feet?
 2. How many francs are there in \$150? (A franc equals 19.3¢.)
 3. If a barrel of flour costs \$5.75, how many barrels can be bought for \$258.75?
 4. If \$640.05 are paid for 75.3 tons of coal, what is the price per ton?
 5. There are 31.5 gallons in a barrel. How many barrels are there in 2787.75 gallons?
 6. I have 96 cubic feet of wood; this is .75 of a cord. How many cubic feet in 1 cord?
 7. A man earns \$162 in 13.5 weeks. What are his wages per week?
 8. I bought a farm of 71.5 acres for \$6220.50. What did it cost me per acre?
 9. There are 2150.4 cubic inches in a bushel. How many bushels are there in 9676.8 cubic inches?
 10. The wheel of a bicycle is 7.25 feet around. How many times will it turn in going a mile, or 5280 feet?

UNITED STATES MONEY.

FRACTIONAL PARTS OF A DOLLAR.

167. Oral Problems.

1. How many 50-cent base-balls can be bought for \$15?
($15 + \frac{1}{2}$, i.e. 15×2)
2. How many 75-cent base-balls can be bought for \$15?
($15 + \frac{3}{4}$, i.e. $15 \times \frac{4}{3}$)
3. At $75\frac{1}{2}$ per pound, how much tea can be bought for \$1?
4. How many hats, at \$1.25 each, can be bought for \$15?
($15 + 1\frac{1}{4}$)
5. Paid \$16 for coffee at $25\frac{1}{2}$ per pound. How many pounds were purchased?
6. At $33\frac{1}{2}\frac{1}{2}$ per pound, how many pounds of butter can be bought for \$32?
7. Find the number of yards of ribbon, at $12\frac{1}{2}\frac{1}{2}$ per yard, that will cost \$45.
8. At $6\frac{1}{4}\frac{1}{2}$ per bar, how many bars of soap will cost \$11?
9. If 4 pieces of violet soap are sold for $25\frac{1}{2}$, how many can be bought for \$9?
10. \$24 is paid for corn at $75\frac{1}{2}$ per bushel. How many bushels are bought?
11. I spent \$30 for lace at $66\frac{2}{3}\frac{1}{2}$ per yard. How many yards did I buy?
12. For \$36 how many pairs of rubber shoes can be bought at $37\frac{1}{2}\frac{1}{2}$ per pair?
13. Oats are $62\frac{1}{2}\frac{1}{2}$ per bushel. How many bushels will \$40 buy?
14. A farmer pays $87\frac{1}{2}\frac{1}{2}$ per bushel for seed rye. If his bill amounted to \$21, how many bushels did he purchase?

15. A storekeeper sold \$33 worth of collars, at $16\frac{2}{3}\%$ each. How many did he sell?
16. At the rate of 3 for 50% , how many collars can be bought for \$25?
17. Corn is worth 20% per can. How many cans will cost \$32?
18. Find the cost of 35 yards of cloth, at \$1.25 per yard.
19. At \$1.25 per yard, how many yards of cloth can be bought for \$35?
20. How many pairs of gloves, at \$1.75 per pair, will cost \$28?
21. When coal is \$5.25 per ton, how many tons can be bought for \$42?
22. Cost of 16 pairs of shoes at \$2.75?
23. 33 jackets at $\$3.33\frac{1}{3}$? 24. 18 yards cloth at $\$2.16\frac{2}{3}$?
25. Paid \$26 for cloth at $\$2.16\frac{2}{3}$ per yard. How many yards did I buy?
26. Find the cost of 16 pairs of skates at $\$1.87\frac{1}{2}$ per pair.
27. If sheep cost $\$3.12\frac{1}{2}$ each, how many can I get for \$75?
28. How many 25-cent balls can be bought for \$8.75?
29. Divide 775 by 25. 30. Divide \$8.25 by 75% .
31. How many square feet are there in a lot 96 feet long, 100 feet wide? In a lot 96 feet long, 25 feet wide?
32. Find the total cost of 32 head of cattle at \$75 per head.
33. How much must be paid for 32 cows at \$37.50 each?
34. If sheep are worth \$3.75 each, how much will a farmer receive for 32 sheep?
35. If a train goes at the rate of 25 miles per hour, how many hours will it take to go 675 miles?

DENOMINATE NUMBERS.

Note. — For the tables of Denominate numbers used in these lessons, see section 93, pages 43-44.

168. Written Exercises.

1. Change 17 lb. 4 oz. to ounces.

$$\begin{array}{r}
 & 16 \text{ oz.} \\
 \times & 17 \\
 \hline
 & 112 \\
 & 16 \\
 \hline
 & 272 \text{ oz.} \\
 \text{Add } & 4 \text{ oz.} \\
 \hline
 & 276 \text{ oz.} \quad \text{Ans.}
 \end{array}$$

Since there are 16 ounces in 1 pound, in
17 pounds there are 272 ounces, etc.

2. Change 37 gal. 3 qt. to quarts.

In this example, we are to multiply 4 quarts (the number in a gallon), by 37, and to add 3 quarts to the product. In practice, however, 4 is taken as the multiplier, and the three quarts are added in. We say 4 sevens are 28, and 3 are 31, writing the 1 ; 4 threes are 12, and 3 are 15.

$$\begin{array}{r}
 & 4 \text{ qt.} \\
 37 \text{ gal. 3 qt.} \\
 \hline
 & 151 \text{ qt.} \quad \text{Ans.}
 \end{array}$$

3. Change 45 bushels to quarts.

Write as here shown, placing above 0 pecks the number of pecks in a bushel, and above 0 quarts the number of quarts in a peck. Multiply 4 pecks by 45, and write the product, 180 pecks, in the proper column; multiply 8 quarts by 180, etc.

$$\begin{array}{r}
 & 4 \text{ pk.} & 8 \text{ qt.} \\
 45 \text{ bu.} & 0 \text{ pk.} & 0 \text{ qt.} \\
 \hline
 & 180 \text{ pk.} & 1440 \text{ qt.} \\
 & \text{Ans. 1440 qt.} &
 \end{array}$$

Change:

4. 63 qt. 1 pt. to pints.
5. 27 bu. 3 pk. to pecks.
6. 48 pk. 7 qt. to quarts.
7. 84 pk. to pints.
8. 7 mi. 60 rd. to rods.
9. 13 hr. 20 min. to minutes.
10. 18 wk. 3 da. to days.

11. Change 151 quarts to gallons and quarts.

Write above 151 quarts the number of quarts in a gallon. Divide 151 by 4 to obtain the number of gallons, 37. Write the remainder, 3, in the column of quarts.

$$\begin{array}{r} 4 \text{ qt.} \\ \hline 151 \text{ qt.} \end{array}$$

37 gal. 3 qt. *Ans.*

12. Change 228 inches to yards and feet.

Divide the number of inches, 228, by 12, to obtain the number of feet, 19. Write this to the left of 228 inches. Reduce to yards by dividing by 3.

$$\begin{array}{r} 3 \text{ ft. } 12 \text{ in.} \\ \hline 19 \text{ ft. } 228 \text{ in.} \\ \hline 6 \text{ yd. } 1 \text{ ft. } \end{array}$$

Ans.

13. 87 pints to quarts and pints.

14. 250 feet to yards and feet.

15. 1650 rods to miles and rods.

16. 864 hours to weeks.

17. 296 quarts to bushels and pecks.

18. 315 ounces to pounds and ounces.

19. 743 months to years and months.

20. 15,000 minutes to days and hours.

21. Add 3 ft. 6 in., 9 ft. 5 in., 12 ft. 3 in.

Write the feet in one column and the inches in another. The sum of the column of inches is 14 inches, or 1 foot 2 inches. Write 2 inches, and carry 1 foot to the next column.

$$\begin{array}{r} 3 \text{ ft. } 6 \text{ in.} \\ 9 \text{ ft. } 5 \text{ in.} \\ \hline 12 \text{ ft. } 3 \text{ in.} \\ \hline 25 \text{ ft. } 2 \text{ in. } \end{array}$$

Ans.

22. 30 min. 15 sec. + 30 min. 18 sec. + 45 min. 24 sec.

23. 9 yr. 3 mo. + 18 yr. 7 mo. + 22 yr. 2 mo.

24. 19 wk. 4 da. + 7 wk. 5 da. + 8 wk.

25. 9 mi. 169 rd. + 84 rd. + 3 mi. 67 rd.

26. 7 yd. 1 ft. + 33 yd. + 19 yd. 2 ft.

27. 18 gal. 1 qt. + 16 gal. 2 qt. + 15 gal. 3 qt.

28. 5 pk. 3 qt. + 6 qt. + 7 pk. 1 qt.

29. 24 bu. 3 pk. + 24 bu. 3 pk. + 24 bu. 3 pk.
 30. 12 qt. 1 pt. + 12 qt. 1 pt. + 12 qt. 1 pt. + 12 qt. 1 pt.
 31. Multiply 12 qt. 1 pt. by 7.

7 times 1 pint = 7 pints = 3 quarts 1 pint. Write 12 qt. 1 pt.
 1 pint in the proper column, and carry 3 quarts. $\times 7$
 7 times 12 quarts = 84 quarts. Carrying 3, we $\underline{87}$ qt. 1 pt. Ans.
 get 87 quarts.

- | | |
|---|---------------------------------|
| 32. 12 qt. 1 pt. \times 4. | 37. 15 wk. 3 da. \times 5. |
| 33. 24 bu. 3 pk. \times 3. | 38. 7 yr. 3 mo. \times 10. |
| 34. 5 pk. 3 qt. \times 9. | 39. 40 min. 35 sec. \times 2. |
| 35. 18 gal. 1 qt. \times 8. | 40. 9 ft. 5 in. \times 12. |
| 36. 33 yd. 1 ft. \times 6. | |
| 41. From 25 ft. 3 in. take 18 ft. 7 in. | |

Take 7 inches from 1 foot 3 inches, or 25 ft. 3 in.
 15 inches. Carry 1 foot to 18 feet, making $\underline{-18}$ ft. 7 in.
 19 feet, etc. 6 ft. 8 in. Ans.

- | |
|---------------------------------------|
| 42. 50 min. 13 sec. - 27 min. 30 sec. |
| 43. 12 yr. 1 mo. - 5 yr. 11 mo. |
| 44. 50 wk. 4 da. - 18 wk. 6 da. |
| 45. 25 ft. - 18 ft. 7 in. |
| 46. 33 yd. 1 ft. - 18 yd. 2 ft. |
| 47. 240 gal. 1 qt. - 94 gal. 2 qt. |
| 48. 83 pk. 3 qt. - 59 pk. 1 qt. |
| 49. 170 bu. 1 pk. - 85 bu. 2 pk. |
| 50. 135 qt. 1 pt. - 67 qt. 1 pt. |
| 51. Divide 87 gal. 2 qt. by 5. |

Dividing 87 gallons by 5, we get 17 gallons,
 and 2 gallons remainder. Change 2 gallons 5)87 gal. 2 qt.
 to 8 quarts, add in 2 quarts, making 10 quarts. 17 gal. 2 qt. Ans.
 Dividing 10 quarts by 5, we get 2 quarts.

52. 50 min. 35 sec. \div 5 57. 387 gal. \div 6
 53. 156 yr. 9 mo. \div 9 58. 222 bu. 3 pk. \div 9
 54. 73 wk. 2 da. \div 3 59. 150 qt. \div 4
 55. 50 mi. 135 rd. \div 7 60. 75 bu. \div 8
 56. 253 yd. 1 ft. \div 10
 61. Divide 87 qt. by 43 qt. 1 pt.

Change the divisor to 87 pints.
 Change the dividend to the same de-
 nomination. 87 pints is contained 2
 times in 174 pints.

$$\begin{array}{r} 43 \text{ qt. } 1 \text{ pt.) } 87 \text{ qt.} \\ 87 \text{ pt.) } 174 \text{ pt.} \\ \hline 2 \end{array}$$

Ans.

62. 50 min. 35 sec. \div 10 min. 7 sec.
 63. 78 bu. \div 9 bu. 3 pk.
 64. 5 lb. 1 oz. \div 9 oz.
 65. 14 ft. 2 in. \div 1 ft. 5 in.

169. Oral Exercises.

1. 3 pints is what part of a gallon?
 (3 pints is what part of 8 pints?)
2. What part of a gallon is 1 qt. 1 pt.?
3. Find the ratio of $\frac{2}{3}$ to $\frac{3}{5}$.
 (Divide 10 fifteenths by 9 fifteenths.)
4. Find the ratio of $\frac{3}{5}$ to $\frac{2}{3}$.
5. How many square feet in a rectangle 12 feet long, 13 feet wide?
6. $\frac{1}{3}$ of a day is how many hours and minutes?
7. 14 ounces is what part of 2 pounds?
8. $\frac{3}{4}$ foot is what part of a yard?
9. A strip of tape 3 yards long is cut into four equal pieces. How many feet and inches are there in each piece?
10. At \$30 per month, how much rent will be paid in 1 year, 8 months?

11. $2\frac{1}{4}$ months is what part of a year?
12. At $\frac{3}{4}$ of a dollar per pound, how much tea can I get for \$1?
13. How many square yards in a room 15 feet long, 18 feet wide?
14. A lot is 25 feet by 100 feet. How many feet of fence will it take to enclose it?
15. 1 pk. 1 qt. is what part of a bushel?
16. 15 is what part of 4 dozen?
17. Reduce $\frac{56}{4}$ to lowest terms.

170. Written Problems.

1. Add 4 da. 6 hr., 9 da. 11 hr., 3 da. 7 hr.
2. What part of a week is 1 da. 18 hr.?
3. If a man receives \$60 interest per year, how much will he receive in 3 yr. $7\frac{1}{2}$ mo.?
4. Reduce 3 da. 18 hr. to minutes.
5. How many days and hours are there in 8100 minutes?
6. $\frac{75}{100}$ of a day is how many hours?
7. How many hours and minutes in .4 day?
8. A man receives \$1456 per year of 52 weeks. What is his salary per week?
9. Find the cost of 1 bu. 1 pk. 1 qt. of potatoes at 8 cents per half-peck.
10. A piece of meat weighing 27 lb. 12 oz. is divided among 6 persons. How many pounds and ounces does each receive?
11. How many bushels and pecks are there in 5 bags, each containing 1 bu. 1 pk?
12. How many gallons, quarts, and pints of ice-cream will be needed to give a half-pint to each one of 67 persons?

13. Find the cost of 7 lb. 10 oz. of tea at 40 cents per pound.

14. From a bin containing 20 bushels of wheat there were sold 10 bu. 3 pk. How much remained?

15. How many yards in a mile? How many feet? How many inches?

16. A field is 16 rods long, 12 rods wide. How many square yards does it contain? What is the perimeter in rods? In feet?

17. How many rails each 30 feet long will be needed for a single track road (two tracks) 40 miles long?

18. A boy steps 33 inches. How many steps will he take in going 2 miles?

19. December 20 the sun rises at Boston at 7.26 A.M. and sets at 4.30 P.M. How long is it between sunrise and sunset? How much longer is the day at Charleston, S. C., where the sun rises at 6.58 A.M. and sets at 4.57 P.M.?

20. On June 21 the sun rises at Boston at 4.23 A.M. and sets at 7.40 P.M. On the same day it rises at Charleston at 4.53 A.M. and sets at 7.11 P.M. What is the length of the day at each place?

MEASUREMENTS.

171. How many square yards in a floor 6 yards long, 5 yards wide?

How many square yards in a ceiling 18 feet long, 15 feet wide?

172. Written Exercises.

1. How many square yards are there in a piece of ground 60 feet long and 30 yards wide?

60 feet = 20 yards. In a plot 20 yards by 30 yards the area = 1 square yard \times 20 \times 30 = 600 square yards, *Ans.*

Chapter Two.

Calculate the number of square yards in the following.

First reduce each side to yards.

- | | |
|----------------------|----------------------|
| 2. 18 yd. by 21 yd. | 7. 33 ft. by 36 yd. |
| 3. 54 ft. by 63 ft. | 8. 27 ft. by 96 ft. |
| 4. 72 in. by 108 in. | 9. 54 ft. by 72 in. |
| 5. 19 yd. by 47 yd. | 10. 48 ft. by 45 ft. |
| 6. 67 yd. by 89 yd. | 11. 54 in. by 72 ft. |

First indicate the operations ; then cancel.

12. Find the number of square yards in a room 18 ft 4 in. long, 22 ft. 6 in. wide.

$$18 \text{ ft. } 4 \text{ in.} = 18\frac{1}{3} \text{ ft.} = \frac{18\frac{1}{3}}{3} \text{ yd.} = \frac{55}{9} \text{ yd.}$$

$$22 \text{ ft. } 6 \text{ in.} = 22\frac{1}{2} \text{ ft.} = \frac{22\frac{1}{2}}{3} \text{ yd.} = \frac{45}{6} \text{ yd.}$$

$$\text{Area} = 1 \text{ sq. yd.} \times \frac{55}{9} \times \frac{45}{6}. \quad \text{Canceling, } \frac{55 \times 45}{9 \times 6} = \frac{275}{6} = 45\frac{5}{6}$$

Ans. 45\frac{5}{6} \text{ sq. yd.}

13. How many square yards in a room 13 ft. 1 in. long, 27 ft. wide ?

$$13 \text{ ft. } 1 \text{ in.} = 157 \text{ in.} = \frac{157}{36} \text{ yd.} \quad 27 \text{ ft.} = 9 \text{ yd.}$$

$$\text{Area} = 1 \text{ sq. yd.} \times \frac{157}{36} \times 9. \quad \frac{157 \times 9}{36} = \frac{157}{4} = 39\frac{1}{4}.$$

Ans. 39\frac{1}{4} \text{ sq. yd.}

14. How many square inches in 12 panes of glass, each 5 inches long, 7 inches wide ?

15. A piece of cloth is 48 yards long, 24 inches wide. How many square yards does it contain ?

16. A merchant imports 8 pieces of cloth, 36 yards to the piece. How many square yards of cloth are there, if it is 32 inches wide ?

17. A tight board fence 6 feet high surrounds a lot 25 feet front by 100 feet deep. How many square feet of boards in the front fence ? In the back fence ? In each side fence ? In the whole ? (Make diagrams.)

Bills.

18. A room is 18 feet long, 15 feet wide, 12 feet high. How many square feet in the floor?

Draw a rectangle to represent the ceiling. Write the dimensions in their proper places, and write in the centre the number of square feet in its surface. Draw diagrams of the four walls; give dimensions and surface of each.

19. How many faces has a cube? If one edge of a cube measures 4 inches, how many square inches are there in the entire surface?

Suppose you wish to make a cube out of a single piece of paste-board. Make a drawing to show the shape of the piece needed, without allowing anything for overlapping parts.

20. The United States government charges a duty of 4¢ per square yard on imported cotton cloth. What duty must the importer pay on a piece containing 24 yards, $\frac{1}{4}$ yard wide?

21. What will be the cost at \$1 per square yard for making a sidewalk 12 feet wide and 30 feet long?

BILLS.

173.

NEW YORK, Oct. 1, 1904.

MRS. WILLIAM JOHNSON,

Bought of FUREY & COMPANY.

	1904						
Aug.	13	44 yd. Carpet	\$.90				
	15	3 Oak Chairs	1.75				
		1 Rocker		12	—		
	19	18 yd. Oil-cloth	.50				
Sept.	27	1 Parlor Suit		75	—		
	19	6 Kitchen Chairs	.75				
		1 Table		4	50		
	26	36 yd. Matting	.33 $\frac{1}{3}$				

Chapter Two.

1. Copy the bill on the preceding page. Supply the missing amounts.

2. Charles W. Wise has bought the following goods of Thos. F. Farley & Co.:

Jan. 3, 1904, 50 pounds of sugar, at $5\frac{1}{2}\%$; 4 pounds of tea, at $62\frac{1}{2}\%$. Jan. 4, 10 pounds of coffee, at $32\frac{1}{2}\%$; 2 barrels of flour, at \$ 5.75. Jan. 9, 24 bars of soap, at $16\frac{2}{3}\%$; 42 pounds of starch, at $8\frac{1}{2}\%$.

Make out a bill dated Feb. 1, 1904.

3. Make out a bill for the following articles bought during March and April. Supply the names of buyer and seller, also the dates:

$23\frac{1}{2}$ yards of silk, at 80% ; $1\frac{1}{2}$ yards of lace, at \$ 2.40; 64 yards of muslin, at $6\frac{1}{2}\%$; 8 spools of sewing silk, at $7\frac{1}{2}\%$; 4 pairs of stockings, at 65% ; 6 yards of linen, at $87\frac{1}{2}\%$; $\frac{1}{2}$ dozen collars, at \$ 2.10.

4. Make out a bill for the following goods, bought June 15:

3 cases of torpedoes, at \$ 2.20; 12 boxes of firecrackers, at \$ $1.62\frac{1}{2}$; 3 gross pinwheels, at \$ 1.35; 5 gross skyrockets, at \$ 3.25; 2 dozen balloons, at \$ 2.25; 45 lanterns, at $9\frac{1}{2}\%$.

NOTE.—The date is written only at the top of the bill when all the articles are bought at one time.

SHORT METHODS—REVIEW.

If the school is to train for life, it must accustom pupils to use modes of calculation followed in the business world.

In their previous work, pupils have employed $\$ \frac{1}{2}$ instead of 25% , $\$ \frac{1}{4}$ instead of $12\frac{1}{2}\%$, etc. They have, for instance, found the cost of 32 pounds at 25% per pound, by multiplying $\$ \frac{1}{4}$ by 32. While the result in example 4 is the same, 25 pounds at 32% , the analysis is different. The following is suggested:

100 pounds at 32% would cost \$ 32, $\frac{1}{4}$ of 100 pounds would cost $\frac{1}{4}$ of \$ 32, or \$ 8.

The rule generally given for the multiplication by 25 is to annex

two ciphers to the multiplicand and to divide by 4. In practice, the ciphers need not be annexed actually or mentally. To multiply 19 by 25, the pupil divides 19 by 4, getting 4 for quotient; to this he adds 75 for the 3 remainder, getting 475 for the result.

174. Oral Exercises.

1. Multiply by 25:

16, 19, 21, 23, 25, 29, 33, 36, 42, 48.

2. How many square feet in a lot 84 feet long, 25 feet wide?

3. What is the weight of 25 barrels of flour, each weighing 196 pounds?

4. Find the cost of 25 pounds of coffee at 32¢ per pound.

5. What will a woman have to pay for 25 yards of silk at \$1.60 per yard?

6. A man sold 25 cows at \$44 each. How much did he receive for them?

7. Multiply 64 by $12\frac{1}{2}$.

8. Find the cost of $12\frac{1}{2}$ bushels of wheat at 96¢ per bushel.

9. At \$12.50 per barrel, how much should I pay for 56 barrels of pork?

10. How many pens in $12\frac{1}{2}$ gross? (144 to gross.)

11. Find the cost of $12\frac{1}{2}$ pounds of tea at 56¢ per pound.

12. How many square yards in a field 96 yards long, 75 yards wide?

175. Sight Exercises.

To multiply 427 by 25 the pupil considers 4 as the divisor. He writes on his paper 1, then 0, then 6, annexing 75 for the 3 remaining.
Ans. 10,675.

Example 5: 25×686 is the same as 686×25 .

Example 9: To multiply by 250, consider three ciphers annexed to the multiplicand.

Example 11: Divide by 8, annexing two ciphers to the quotient when there is no remainder. Annex $12\frac{1}{2}$ when the remainder is 1; 25, when the remainder is 2; etc.

Example 19: Consider three ciphers annexed and divide by 8.

Write only the answers :

- | | | |
|---------------------|--------------------------------|---------------------------------|
| 1. 837×25 | 8. 25×2174 | 15. $12\frac{1}{2} \times 1084$ |
| 2. 763×25 | 9. 837×250 | 16. $12\frac{1}{2} \times 2196$ |
| 3. 934×25 | 10. 763×250 | 17. $12\frac{1}{2} \times 3670$ |
| 4. 508×25 | 11. $864 \times 12\frac{1}{2}$ | 18. $12\frac{1}{2} \times 6281$ |
| 5. 25×686 | 12. $776 \times 12\frac{1}{2}$ | 19. 864×125 |
| 6. 25×301 | 13. $236 \times 12\frac{1}{2}$ | 20. 776×125 |
| 7. 25×1039 | 14. $404 \times 12\frac{1}{2}$ | 21. 125×1020 |

176. Sight Exercises.

Pupils do much unnecessary work in rearranging numbers and in writing fractions over again with a common denominator. A few of these examples should be written on the blackboard from time to time, and the teacher should require the pupil to write nothing but the answers.

Add :

- | | | |
|----------------------------------|-----------------------------------|-----------------------------------|
| 1. $3\frac{1}{2} + 5\frac{1}{2}$ | 4. $11\frac{7}{8} + 4\frac{1}{4}$ | 7. $8\frac{4}{5} + 6\frac{7}{8}$ |
| 2. $4\frac{1}{2} + 8\frac{1}{4}$ | 5. $7\frac{4}{5} + 9\frac{7}{10}$ | 8. $15\frac{2}{5} + 8\frac{1}{2}$ |
| 3. $9\frac{2}{3} + 7\frac{5}{6}$ | 6. $5\frac{3}{4} + 2\frac{2}{5}$ | 9. $9\frac{2}{5} + 5\frac{2}{3}$ |

177. Subtract at sight :

- | | | |
|--------------------------------------|-------------------------------------|-------------------------------------|
| 10. $23\frac{7}{10} - 19\frac{2}{5}$ | 14. $9\frac{7}{8} - 2\frac{1}{2}$ | 18. $35\frac{1}{5} - 3\frac{1}{4}$ |
| 11. $16\frac{3}{4} - 9\frac{3}{8}$ | 15. $10\frac{1}{4} - 5\frac{1}{12}$ | 19. $11\frac{2}{7} - 6\frac{1}{4}$ |
| 12. $18\frac{1}{3} - 3\frac{1}{4}$ | 16. $14\frac{1}{4} - 8\frac{3}{10}$ | 20. $43\frac{3}{10} - 8\frac{3}{4}$ |
| 13. $15\frac{3}{4} - 8\frac{1}{5}$ | 17. $27\frac{1}{5} - 7\frac{1}{3}$ | 21. $50\frac{1}{5} - 4\frac{1}{4}$ |

178. Multiply at sight, $18\frac{1}{4} \times 4$.

$\frac{1}{4} \times 4 = 3$. 4 eights are 32, and 3 are 35 (put down 5). 4 ones are 4 and 3 are 7 (put down 7). *Ans.* 75.

The pupil should write only the answers.

22. $27\frac{1}{2} \times 10$

27. $15\frac{7}{8} \times 3$

32. $37\frac{1}{2} \times 3$

23. $33\frac{1}{8} \times 12$

28. $13\frac{3}{4} \times 4$

33. $45\frac{1}{4} \times 5$

24. $16\frac{5}{8} \times 8$

29. $20\frac{1}{2} \times 11$

34. $23\frac{1}{8} \times 4$

25. $17\frac{3}{4} \times 8$

30. $40\frac{3}{4} \times 5$

35. $17\frac{1}{8} \times 6$

26. $19\frac{3}{4} \times 6$

31. $16\frac{1}{4} \times 7$

179. Divide at sight.

When the divisor is an integer less than 12, the pupil should not reduce the mixed number in the dividend to an improper fraction. To divide $246\frac{1}{4}$ by 3, the pupil first gets the whole number of the quotient 82, he then divides $\frac{1}{4}$ by 3. *Ans.* $82\frac{1}{4}$.

In dividing $248\frac{1}{4}$ by 4, the pupil obtains 62 as the quotient of 248 by 4; he then finds $\frac{1}{4}$ of $\frac{1}{4}$, which is $\frac{1}{16}$. *Ans.* $62\frac{1}{16}$.

In dividing $202\frac{1}{2}$ by 5, the quotient is 40, and the remainder is $2\frac{1}{2}$, which is reduced to $\frac{1}{2}$. One-fifth of this is $\frac{1}{10}$. *Ans.* $40\frac{1}{10}$.

In dividing $183\frac{1}{4}$ by 6, the quotient is 30 with a remainder of $3\frac{1}{4}$, or $\frac{13}{4}$. $\frac{1}{4}$ of $\frac{13}{4}$ is $\frac{1}{16}$. *Ans.* $30\frac{1}{16}$.

36. $3)45\frac{3}{4}$

41. $8)37\frac{1}{2}$

46. $7)97\frac{3}{14}$

37. $4)56\frac{1}{4}$

42. $9)48\frac{1}{4}$

47. $10)87\frac{1}{4}$

38. $12)36\frac{1}{4}$

43. $6)25\frac{1}{4}$

48. $4)66\frac{1}{4}$

39. $5)72\frac{1}{4}$

44. $7)10\frac{1}{4}$

49. $3)94\frac{1}{4}$

40. $11)83\frac{3}{4}$

45. $6)75\frac{3}{4}$

50. $5)83\frac{3}{4}$

SIGHT APPROXIMATIONS.

180. Give approximate answers in whole numbers. Solve for the exact answers.

1. $17\frac{3}{10} \times 3\frac{8}{9}$; or, about $17 \times$ about 4.

2. $25\frac{1}{8} + \frac{2}{3}\frac{1}{3}$; or, about $25 + \frac{1}{4}$ nearly.

- | | |
|---|--|
| 3. $6\frac{1}{8} \times 6\frac{1}{8}$ | 7. $799\frac{11}{12} + 99\frac{11}{12}$ |
| 4. $300\frac{1}{25} \div 11\frac{11}{11}$ | 8. $7\frac{9}{100} \times 7\frac{9}{10}$ |
| 5. $86\frac{2}{3} \times 7\frac{1}{2}$ | 9. $7\frac{1}{3} \times 11\frac{1}{8}$ |
| 6. $35\frac{1}{4} \div 3\frac{1}{2}\frac{1}{8}$ | 10. $64\frac{1}{55} \times \frac{1}{8}$ |

181. Give answers in whole numbers:

- | | |
|---|--------------------------|
| 1. 5.75×9.999 ; or, 5.75×10 nearly. | 7. $799.9 \times .103$ |
| 2. $24.002 \div .4999$; or, $24 \div$ nearly $\frac{1}{2}$. | 8. 7.999×7.999 |
| 3. 25.125×11.834 | 9. 7.001×12.003 |
| 4. $36.843 \div 6.105$ | 10. $64.001 \div .249$ |
| 5. $86.4 \div .983$ | |
| 6. 32.04×5.001 | |

182. Give the cost, approximately, of:

1. 49 horses at \$199 each. (\$ 200×49 .)
2. 199 yd. 2 ft. 11 in. of cloth at \$2.50 per yard.
3. 3 lb. 15 oz. of butter at $25\frac{1}{4}$ per lb.
4. 398 coats at \$12 each.
5. 7 bu. 3 pk. 7 qt. potatoes at \$2 per bushel.
6. 798 base-balls at 25 cents each.
7. 19 gal. 3 qt. 1 pt. alcohol at \$2.49 per gallon.
8. 995 lb. tea at $59\frac{1}{4}$ cents per pound.
9. 7 houses at \$4995 each.
10. 507 pounds of hay at 99 cents per 100 pounds.

183. Oral Review Exercises.

1. What is $\frac{1}{5}$ of 60? $\frac{3}{4}$ of 35?
2. A man sold a boat for \$8, which was $\frac{2}{3}$ of what it cost him. What did it cost him?
3. A man having \$35, gave away $\frac{2}{5}$ of it. How much had he left?

4. How many inches are there in $\frac{1}{2}$ of a yard? $\frac{3}{4}$ of a yard? $\frac{5}{8}$ of a yard?
5. If 6 eggs cost 12 cents, what will 5 dozen cost?
6. How much is $\frac{1}{2}$ less $\frac{1}{4}$? $\frac{1}{3}$ less $\frac{1}{4}$?
7. Change to improper fractions: $7\frac{1}{2}$, $9\frac{1}{3}$, $6\frac{1}{5}$, $2\frac{1}{15}$, $6\frac{1}{2}$.
8. How many apples at $2\frac{1}{2}$ apiece are worth as much as 4 peaches at $5\frac{1}{2}$ apiece?
9. Which is the greater and how much: $\frac{1}{2}$ of \$24, or $\frac{1}{3}$ of \$25?
10. Change to mixed numbers: $\frac{87}{4}$, $\frac{65}{7}$, $\frac{47}{15}$, $\frac{41}{8}$, $\frac{50}{9}$.
11. There are 45 pupils in school and $\frac{2}{3}$ of them are girls. How many are boys?
12. Add $8\frac{1}{4}$ and $7\frac{1}{2}$. $5\frac{1}{2}$ and $7\frac{1}{5}$.
13. If it takes 5 men 15 days to do a piece of work, how long will it take 10 men to do it?
14. What will 2 bushels of corn cost, if $\frac{1}{2}$ peck costs 15 cents?
15. If it costs 25 cents to set one shoe, what will it cost to shoe a span of horses all around?
16. Bought 5 yards of ribbon at $16\frac{1}{2}$ ¢, and 3 yards of linen at $75\frac{1}{2}$ ¢, and gave a two-dollar bill. What was my change?
17. If 7 yards cost $84\frac{1}{2}$ ¢, how many yards can be purchased for \$1?
18. If 6 oranges cost $15\frac{1}{2}$ ¢, how much will 8 cost?
19. $1\frac{1}{2}$ pecks of peanuts cost \$0.48; what will one quart cost?
20. Two boys walked in opposite directions; one walked 5 miles an hour, the other 4 miles an hour. How far apart were they in six hours?
21. If $\frac{1}{2}$ of a yard of cloth cost $6\frac{1}{2}$ ¢, how much cloth can be bought for $40\frac{1}{2}$ ¢?

22. At $\frac{1}{2}$ a dollar per day for board, how many days' board can you get for \$7.50?
23. Charles picked $\frac{1}{2}$ peck of berries, William $\frac{1}{3}$ peck, and Alfred $\frac{1}{4}$ peck. How much did they all pick?
24. How much more is $\frac{3}{4}$ of 80¢ than $\frac{3}{4}$ of 75¢?
25. A boy bought $3\frac{1}{2}$ pounds of butter for his mother. How many ounces did he buy?
26. If a man is 50 years old now, how old was he 22 years ago?
27. Mary works 4 hours and 40 minutes, and Nellie works 2 hours and 20 minutes. How many hours do they both work?
28. If you should receive 15 cents at one time, 26 cents at another time, and 14 cents at another time, how much would you receive in all?
29. If you had $\frac{4}{5}$ of a dollar, and should buy a pound of soda for 8¢ and a pound of tea for 45¢, how much would you have left?
30. If you give a boy \$10, how many mills do you give him?
31. $50 - 12 - 9 - 19 =$
32. $72 - 7 \text{ times } 9 =$ what number?
33. 45 is how much less than 5 times 12?
34. $(\frac{3}{4} \text{ of } 80) + 25 =$
35. $(35 + 15) - (14 \div 9) =$
36. $\frac{6}{7} =$ how many sixths?
37. $2\frac{1}{2} =$ how many fourths?
38. Give the exact divisors of 20. 40. From $\frac{3}{4}$ take $\frac{1}{4}$.
39. Give the three factors of 30. 41. $2\frac{1}{2} + \frac{1}{2} - \frac{1}{4} =$
42. At 12 cents a dozen, what will a gross of buttons cost?

43. How many inch cubes will exactly cover a square foot of surface?
44. What does $\frac{1}{4}$ of anything mean?
45. 1 gallon 2 quarts and 1 gallon 1 quart are how many quarts?
46. If 4 yards of muslin cost 48 cents, how much will one-third of a yard cost?
47. Paid \$4.86 for 6 bushels of rye. What was the price per bushel?
48. Bought 3 dolls at 49 cents each. Total cost?
49. If 12 hats cost \$7, what will be paid for 36 hats?
50. If 2 pounds and 5 ounces butter cost 74 cents, what will be the cost of 3 pounds and 2 ounces?
51. How many bottles holding $1\frac{1}{2}$ pints will be needed to contain $2\frac{1}{4}$ gallons?
52. A bag of flour contains $\frac{1}{8}$ of a barrel of 196 pounds. How many pounds does the bag contain?
53. What will be the cost of a dozen heads of cauliflower at the rate of 2 for 25 cents?
54. Twenty examples are given out. A pupil that correctly answers all receives 100 per cent. What per cent will a pupil receive that solves 16 examples?
55. A woman receives \$40 interest a year. How much does she receive in 3 years and 6 months?
56. A man bought some cows at \$35 each, and the same number at \$45 each. What was the average price?
57. A girl received 100 credits in each of three studies, and 80 credits in the fourth. What was the total number of credits in the four studies? What was her average?
58. A square floor contains 144 square feet. How many feet long and wide is it?

59. $\frac{3}{4}$ yard cloth costs $\$ \frac{3}{4}$. What is the price per yard?

NOTE. — In dividing one fraction by another mentally, reduce both to their common denominator.

$\frac{3}{4}$ price of a yard = $\$ \frac{3}{4}$. $\frac{1}{3}$ price of a yard = $\$ \frac{1}{3}$. Multiplying by 12, 8 times price of a yard = $\$ 9$.

60. A man owning $\frac{2}{3}$ of a vessel sells $\frac{2}{3}$ of his share. What part of the vessel does he then own?

61. A barrel contains 196 pounds of flour; the barrel weighs 24 pounds. What is the weight of both?

62. A family uses $3\frac{1}{2}$ pounds of sugar per day. How long will $24\frac{1}{2}$ pounds last?

63. How much will be the cost of 3 pounds of 25-cent coffee and 1 pound butter at 36¢?

64. If $\frac{1}{4}$ of a pound of candy costs 30¢, what will be the cost of $\frac{7}{8}$ of a pound?

NOTE. — 6 eighths cost 30¢, what will 7 eighths cost?

65. A tailor has a piece of cloth containing $2\frac{1}{2}$ yards; he sells $1\frac{3}{4}$ yards. What part of the piece does he sell?

66. How many quarts in 1 bushel 1 peck and 1 quart?

67. Reduce $\frac{36}{48}$ to lowest terms.

68. $24\frac{1}{2}$ yards of cloth are used for 7 coats. How many yards in each coat?

69. If cloves are worth 20¢ per $\frac{1}{4}$ pound, how much will be paid for 7 ounces?

70. At 3 oranges for 5¢, what will be the cost of $1\frac{1}{2}$ dozen oranges?

71. My purchase amounts to \$1.29. I give the store-keeper a \$2 bill. How much change do I receive?

72. A bushel of nuts was sold for 5¢ per quart. How much money did it bring?

73. How many days in the summer months, June, July, and August?

74. John had 40 cents. After earning 24 more, he spent his money for marbles at 4 cents each. How many did he buy?

75. George was sent to the store with 50¢. He bought 6 pounds of rhubarb at 2¢ a pound, and two bunches of radishes at 5¢ a bunch. How much money had he left?

76. At \$10 a ton what will be the cost of 1000 pounds?

77. There are 16 rooms in a building with 50 desks in a room. How many desks in all?

78. Edgar earned \$2.75 one week, and \$2.50 the next week. How much did he earn in both weeks?

79. \$6 is $\frac{3}{4}$ of how many dollars?

80. Charles began work at 2.45 P.M. and stopped at 5.15 P.M. How long did he work?

81. $29 + 18 + 30 + 9 + 8 + 7 = ?$

82. $\frac{1}{2}$ of 22 is how many times 4?

83. Bought a horse for \$45 and a saddle for \$35, and then sold them, gaining \$20. For how much were they sold?

84. Add these numbers: 12, 15, 9, 13, 11, 7, and 24.

85. If you buy 6 yards of tape at 7 cents a yard, and 4 yards of silk at 7 dollars a yard, what will you give for both tape and silk?

86. Bought 8 firkins of butter for \$72, and gave 2 of them for 9 yards of cloth. What was a yard of the cloth worth?

87. Mr. Brown mixed 3 pounds of black tea worth 40 cents a pound with 1 pound of 60-cent green tea. What is the mixed tea worth a pound?

184. Written Review Exercises.

1. In 6987 days how many minutes?
2. Find the cost of 1,588,000 pounds of coal at \$5.98 a ton.
3. How many cords of wood, at \$7.85 a cord, can be purchased for \$59,730.65?
4. Divide \$3,245,530 by 468.
5. Bought 8 bushels 3 quarts valuable seed at seven dollars and eight cents a quart. How much did the seed cost?
6. What is the cost of 19 gallons 2 quarts of cologne at 90¢ a quart?
7. Divide $\frac{1}{4}$ of \$60,800 equally among 75 persons.
8. Bought a house for \$23,650, and land for \$73,640. For how much must I sell them to gain \$4500?
9. Find the greatest common divisor of 45 and 135.
10. A grocer bought 7200 gallons of oil, one-third of it leaked out, and he sold the remainder at 25 cents a gallon. How much did he receive for it?
11. From two and four-tenths yards take .445 of a yard.
12. Add the numbers from 490 to 505 (inclusive).
13. If 56 pounds of sugar cost \$3.08, what will 24 pounds cost?
14. If 42 gallons 3 quarts 1 pint of cream cost \$27.44, what will 32 pints cost?
15. A man's bill at a provision store was \$6.66. He had bought two pecks of peas for \$0.54 and some beans for \$0.36. The rest of the bill was for sirloin steak at \$0.32 per pound. How many pounds of meat had he bought?
16. From 1,890,070 take 990,979.
17. If a train travels 45 miles per hour, how far will it go from half-past 9 in the morning to a quarter of 7 in the evening?

18. A mechanic saved \$35 per month for 11 months, and \$20 the twelfth month. His expenses averaged \$3 each day of the year. What were his daily wages for the 300 days he worked?

19. A 160-acre farm consists of 5 fields. The first contains 17.38 acres, the second 29.4 acres, the third 35.073 acres, the fourth 25.875 acres. How many acres are there in the fifth field?

20. How many seconds in 7 hours 15 minutes?

21. Find the total cost of 2 dozen rockets at \$7.50 per gross, 3 dozen Roman candles at \$9.60 per gross, and 24 dozen pinwheels at \$1.35 per gross.

(1 gross = 12 dozen.)

22. Three lots of tea were sold for \$330. The second contained twice as much as the first, and the third three times as much as the first. The third lot contained 330 pounds. Find the selling price of the tea per pound.

23. A barrel of molasses contained 40 gallons. One-fourth of it leaked out. If the molasses cost 45 cents per gallon, what price must be charged for the remainder so that there will be no loss?

24. If $12\frac{1}{2}$ dozen rockets cost \$5.75, what will 15 dozen cost?

25. Show by drawings that $\frac{1}{2} = \frac{4}{8}$, and that $\frac{3}{4} = \frac{6}{8}$.

26. Write the first five prime numbers that are greater than 7.

27. Find the greatest common divisor of 1220 and 2013.

28. Find the least common multiple of 12, 15, 14, 6, 21, 21, and 24.

29. Find the prime factors of 1140.

30. Add $3\frac{1}{2}$, $\frac{2}{3}$, $\frac{5}{6}$, and $\frac{7}{8}$ of $7\frac{1}{2}$.

31. From $14\frac{7}{16}$ pounds of butter, $5\frac{1}{4}$ pounds were sold to one person and $3\frac{7}{8}$ to another. How much remained?

32. A man bought 4 bushels of wheat for $3\frac{3}{4}$ dollars. What fraction of a dollar did one bushel cost?
33. If $\frac{2}{3}$ of a bushel of oats will last a horse one day, how long will $4\frac{1}{2}$ bushels last?
34. In two months Ann will be 15 years old. How old was she nine months ago?
35. A boy has to walk from his home to a house $1\frac{3}{4}$ miles east of his home, from there to a place $2\frac{1}{2}$ miles west of his home, and then home. How far has he to walk?
36. I lost $\frac{1}{4}$ of my money, then found $\frac{1}{4}$ of what I had lost, and then had 64 cents. How much had I at first?
37. Quotient $24\frac{1}{2}$, divisor $3\frac{1}{2}$. What is the dividend? The product is $2\frac{3}{4}$, and one factor is $\frac{2}{3}$. What is the other factor?
38. Bought $3\frac{1}{4}$ yards of muslin at 7 cents a yard, $5\frac{1}{2}$ yards of ribbon at $3\frac{1}{2}$ cents a yard, and $2\frac{1}{8}$ yards of cloth at \$1.75 per yard, and gave a ten-dollar note in payment. How much change did I receive?
39. Write seven million nine thousand nineteen.
40. A milliner sells 3 pieces of ribbon at 18 cents per yard. They measure $4\frac{3}{8}$ yards, $3\frac{1}{4}$ yards, and $5\frac{5}{12}$ yards respectively. What does she receive for the ribbon?
41. How many feet and inches in $1\frac{5}{12}$ of a yard?
42. To make powder, a man mixes $7\frac{1}{4}$ pounds of saltpetre, $1\frac{7}{8}$ pounds of sulphur, and as much charcoal as sulphur. How many pounds of powder will there be?
43. Four men form a partnership; the first furnishes $\frac{1}{4}$ of the capital, the second $\frac{1}{3}$, and the third $\frac{5}{12}$. What fraction of the capital is furnished by the fourth?
44. I pay 15 cents more for a half-pound of tea than I pay for a quarter-pound of the same tea. What is its price per pound?

45. After doing $\frac{1}{4}$ of a piece of work, a man requires 3 days more to finish it. How many hours does he take to do the whole work if he works 8 hours per day?

46. If 1 pound 7 ounces of coffee cost 46 cents, what will 3 pounds 9 ounces cost?

47. Add 6 hours 50 minutes and 17 hours 10 minutes.

48. 15 men do a piece of work in $10\frac{1}{2}$ days. How long would it take 5 men to do the same work?

49. To make a cloak, 3 yards of cloth $1\frac{1}{2}$ yards wide are required. How much cloth $\frac{1}{4}$ yard wide would be required?

50. In 3 years 4 months a gas company manufactures 4,200,000 cubic feet of gas. How many cubic feet are manufactured per year?

51. If $2\frac{1}{2}$ dozen hats cost \$80, what will be the cost of 3 hats?

52. A boy hires a boat at 20 cents per hour. How much should he pay if he uses it from 20 minutes before 9 A.M. until 10 minutes past 1 P.M.?

53. A and B kill an ox. A takes $\frac{5}{6}$ and B the remainder. If B's share weighs $361\frac{1}{2}$ pounds, what is the weight of the ox?

54. A grocer buys 30 dozen eggs at 18 cents per dozen. He sells them at the rate of 15 eggs for 25 cents. What is his profit?

55. How many cents in $\frac{5}{16}$ of a dollar?

56. What fraction of $18\frac{1}{4}$ is $6\frac{1}{2}$?

SUGGESTION.—What fraction of 18 is 6? Which is the divisor?

57. A farmer buys a horse for \$140, and sells it at an advance of $\frac{3}{20}$ of the cost. What is the selling price?

58. In 1903, A was 36 years old and B was $1\frac{1}{4}$ times as old. In 1894, B was how many times as old as A?

59. From the sum of $18\frac{7}{16}$ and $25\frac{1}{4}$ take their difference.
 60. If $2\frac{1}{4}$ acres of land cost \$220, what will be the cost of $17\frac{1}{4}$ acres?

Note. — Indicate the operations, and cancel.

61. A can do a piece of work in 6 days, B can do it in 6 days, C can do it in 6 days. How long will it take all three working together?

62. Find the value of $\frac{\frac{2}{3} \text{ of } \frac{3}{4} \text{ of } 2\frac{1}{2}}{\frac{1}{2} \text{ of } 3\frac{1}{2}}$.

63. A man sold a horse for $\frac{1}{4}$ of its cost, losing \$40. What did the horse cost him?

64. I have an oblong piece of land which is 96 feet long and 72 feet wide. There are three gateways; one is two feet wide, one is three feet wide, and the other is four feet wide. How many feet of fence will it take to go around the field?

65. Add: \$83.34; \$67.58; \$50.37; \$62.50; \$35.75; \$62.50; \$35.75; \$63.81; \$67.59; \$86.37; \$37.50; \$15.09; \$57.32; \$49.63.

66. A boy bought a suit of clothes for \$21, boots for \$3.50, overcoat for \$15, and gloves for 50¢. Paid for these things in work at \$1.25 per day. How many days did he work?

67. If \$36.53 will buy $6\frac{1}{2}$ yards of cloth, how much will $\frac{1}{2}$ yard cost?

68. If two quarts of peaches cost 25¢, what will half a bushel cost?

69. How many geographies at 90¢ apiece can be bought for \$54?

70. Find the least common multiple of 6, 24, 32, 48, 96.

71. Add: 87.5; 7004.3; 500.004; 21,090; 5040.29.

72. Spent \$290 for horses, \$286.75 for carriages, \$150.80 for harness, and \$12.75 for blankets. Gave 4 fifty-dollar bills and 2 one-hundred-dollar bills. What did I still owe?

73. How many bushels of oats will a span of horses eat in 4 weeks, if they eat 24 quarts a day?

74. How many bottles, each holding $\frac{1}{2}$ pint, will it take to hold 725 gallons and 2 quarts of oil?

75. How many pounds of rice at 12¢ a pound, will pay for 4 bushels 2 pecks of nuts at 8¢ a pint?

76. A man had \$600. He bought a horse for \$225, a carriage for \$190.12, and a harness for \$40.76. He then gave away $\frac{1}{4}$ of what he had left. What did he still have?

77. Find the greatest common divisor of 18, 24, 36.

78. The least common multiple of 12, 20, and 30.

79. Find the cost of 18,756 feet of lumber at \$30 per 1000 ft.

80. A field is 14.25 rods long by 7.4 rods wide. What is its area in square rods?

81. A rod is 16.5 feet; how many feet are there in 24 rods? How many rods are there in 231 feet?

82. How many marks are there in \$100? (A mark is equal to 23.8 cents.)

83. Add 3 and 4 tenths, 96 thousandths, 100 and 5 thousandths, 27 hundredths.

84. From 2700 take 27 hundredths.

85. Multiply 8 and 4 tenths by 9 and 25 hundredths.

86. Divide 96 and 75 hundredths by 322 and 5 tenths.

87. A load of hay, at 75 cents per 100 pounds, cost \$13.98. What was the weight of the hay?

88. The circumference of a circle is 3.1416 times the diameter. How many inches in the circumference of a circle whose diameter is 20 inches?

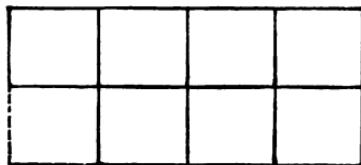
89. Show by a diagram the number of pieces of wire $\frac{1}{4}$ yard long that can be made from 4 yards of wire.

90. Show by a diagram that three-fourths of 1 is equal to one-fourth of 3.

91. If two-thirds of a yard of material will make an apron, how many aprons can be made from two yards? Show by a diagram.

92. A boy paid 6 cents for three-eighths of a pie. What would be the cost of the whole pie at the same rate? Make a drawing.

93. Seven-eighths of an acre of land is sold for \$140. What is the price of an acre?



CHAPTER III.

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DECIMALS.

185. Preliminary Exercises.

1. Write seven tenths as a common fraction. As a decimal.
2. Write three hundredths as a common fraction. As a decimal.
3. Write thirty-one thousandths as a common fraction. As a decimal.

4. Read the following:

.3	.09	.043
.17	.007	.241

5. Write each of the foregoing decimals as a common fraction.

186. Notation and Numeration of Decimals.

1. 7 tenths, or $\frac{7}{10}$, is written .7.
2. 3 hundredths, or $\frac{3}{100}$, is written .03.
3. 53 hundredths, or $\frac{53}{100}$, is written .53.
4. 9 thousandths, or $\frac{9}{1000}$, is written .009.
5. 19 thousandths, or $\frac{19}{1000}$, is written .019.
6. 419 thousandths, or $\frac{419}{1000}$, is written .419.
7. 67 ten-thousandths, or $\frac{67}{10000}$, is written .0067.
8. 1031 hundred-thousandths, or $\frac{1031}{100000}$, is written .01031.

NOTE. — In the foregoing examples, it will be observed that the number of places to the right of the decimal point is equal to the number of ciphers in the denominator of the corresponding common fraction.

187. Write the following as decimals:

1. 314 ten-thousandths.

Since $\frac{1}{10000}$ has a denominator containing four ciphers, the decimal must have four places; a decimal cipher must be written after the decimal point.

Ans. .0814.

To write a decimal, write the numerator, and from the right, point off as many decimal places as there are ciphers in the denominator, prefixing decimal ciphers, if necessary.

NOTE. — Ciphers between the decimal point and the first significant figure of the numerator are called *decimal ciphers*.

2. 217 hundred-thousandths.
3. 83 hundredths.
4. 7 millionths.
5. 345 thousandths.
6. 27 ten-thousandths.
7. 325 and 7 thousandths.

Ans. 325.007. This is called a *mixed decimal*, which consists of an integer and a decimal.

188. The word *and* is used in reading mixed numbers or mixed decimals to separate the integer from the common fraction or the decimal.

8. 42 and 56 hundred-thousandths.
9. 150 and 62 millionths.
10. 489 and 3 hundredths.

189. Read the following:

1. .0346.

Since there are four decimal places, the denominator is 1 with four ciphers, 10000.

Ans. 346 ten-thousandths.

- | | |
|------------|--------------|
| 2. 654.15 | 6. 25.006347 |
| 3. .000209 | 7. 3.259 |
| 4. 60.0207 | 8. .002468 |
| 5. 684.007 | 9. 200.0035 |

200.0035 read as 200 and 35 ten-thousandths might be mistaken for 235 ten-thousandths. It should be read 200 units and 35 ten-thousandths, or 200 whole number and 35 ten-thousandths.

- | | |
|---------------|----------------|
| 10. 1000.0006 | 12. 2300.00021 |
| 11. 300.075 | 13. 400.000007 |

190. Changing Common Fractions to Decimals.

Reduce $\frac{3}{32}$ to a decimal.

$$\begin{array}{r} .09375 \\ 32) 3.00000 \\ \underline{-288} \\ 120 \\ \underline{-96} \\ 240 \\ \underline{-224} \\ 160 \\ \underline{-160} \end{array}$$

$\frac{3}{32}$ means $3 \div 32$. Performing the indicated division, we obtain the quotient .09375. $\frac{3}{32} = .09375$, *Ans.*

Divide the numerator, with the necessary ciphers annexed, by the denominator. The number of decimal places in the quotient will be equal to the number in the dividend.

Reduce to decimals:

1. $\frac{1}{800}$

2. $\frac{1}{40}$

3. $\frac{2}{25}$

4. $\frac{25}{8}$

5. $\frac{17}{84}$

6. $\frac{3}{16}$

7. $\frac{8}{500}$

8. $\frac{1}{87}$

9. $\frac{21}{4000}$

10. $\frac{7}{2000}$

11. $\frac{18}{7}$

12. $\frac{7}{125}$

13. $\frac{28}{8}$

14. $\frac{17}{16}$

15. $\frac{11}{250}$

16. $\frac{1}{825}$

17. $\frac{875}{64}$

18. $\frac{18}{125}$

19. $\frac{1}{256}$

20. $\frac{7}{512}$

21. $\frac{1}{1024}$

191. Changing Decimals to Common Fractions.

What is the denominator of a decimal fraction?

What prime numbers are contained in 10? What are the only factors of 10? The prime factors of 100? Of 1000?

Can $\frac{7}{1000}$ be reduced to lower terms? Why? Can $\frac{8}{100}$ be reduced to lower terms? Why? Can $\frac{485}{1000}$ be reduced to lower terms? How can we tell by merely looking at a decimal whether or not it can be reduced to a common fraction of lower terms?

192. Written Exercises.

Reduce the following to common fractions — lowest terms. Do not find the greatest common divisor.

1. Reduce .0064 to a common fraction — lowest terms.

$$.0064 = \frac{64}{10000} = \frac{16}{2500} = \frac{4}{625}, \text{ Ans.}$$

2. Reduce .039 to a common fraction.

$$\frac{39}{1000}, \text{ Ans.}$$

This cannot be reduced to lower terms, since 39 is not divisible by 2 or 5.

3. Reduce .900 to a common fraction — lowest terms.

$$\frac{900}{1000} = \frac{90}{100} = \frac{9}{10}, \text{ Ans.}$$

Omit the decimal point. Write in the form of a common fraction, and reduce to lowest terms.

Ciphers at the right of a decimal cancel ciphers in the denominator; they do not, therefore, affect the value of the decimal, and they should be omitted.

193. Reduce to common fractions:

1. .0075	8. .37500	15. .0009
2. .36	9. .144	16. .816
3. .0275	10. .0006	17. .15625
4. .44	11. .27	18. .0375
5. .03125	12. .027	19. .00625
6. .486	13. .00365	20. .096
7. .3750	14. .96	21. .326

ADDITION OF DECIMALS.

194. Add the following, reducing the common fractions to decimals.

1. $18\frac{1}{4} + 9.084 + 25\frac{1}{20} + 163 + 2.09 + .0975$	18.75 9.084 25.05 163. 2.09 <hr style="border-top: 1px solid black;"/> <u>.0975</u>
--	--

Write the decimals so that tenths, hundredths, etc., stand in the same column, etc.

Write the numbers so that decimal points stand in a column. Add as in integers, and place the point in the sum directly under the points above.

2. $275\frac{3}{100} + 58.64 + 8.6796 + 30\frac{1}{2} + 8\frac{2}{5} + 99$
3. $84\frac{7}{10} + 93\frac{8}{100} + 3\frac{141}{1000} + \frac{7}{10000} + 684.1 + \frac{3}{4}$
4. $250 + 1875.93 + 16\frac{4}{5} + \frac{2}{5} + 608.94 + .0005$
5. $8.6796 + 96.8 + 18\frac{3}{4} + 34\frac{1}{25} + 1876$
6. $40\frac{4}{25} + 7.2832 + 86.3 + 128.46 + 2\frac{1}{25}$
7. $540 + 1.32 + .576 + \frac{81}{10000} + 68\frac{5}{10} + 395\frac{1}{4}$
8. $5.308 + .25 + 567.8 + 8.4825 + 49.795 + 8\frac{1}{45}$
9. $7.08 + 23.04 + 8\frac{7}{10} + .348 + 3\frac{1}{25} + 7.00019$
10. $8\frac{999}{1000} + 8\frac{1}{5} + 507 + 28\frac{4}{100} + 6.8819$

SUBTRACTION OF DECIMALS.

195. Give answers in decimals:

1. $275.3 - 87\frac{2}{5}$

Arrange the decimals as in addition, tenths under tenths, etc.

275.3		87.4
		188.26
		<i>Ans.</i>

Write the numbers so that the decimal point of the subtrahend is directly under the decimal point of the minuend; subtract as in integers, and place the point in the remainder directly under the points above.

2. $387\frac{3}{5} - 99.0127$
3. $1000 - 10\frac{1}{1000}$
4. $62.365 - 48\frac{3}{4}$
5. $198\frac{3}{4} - 13.6431$
6. $24\frac{8}{10} - 9\frac{8}{1000}$
7. $2345 - 345\frac{1}{32}$
8. $168\frac{3}{40} - 54.8759$
9. $618.42 - 576\frac{1}{4}$
10. $1847\frac{11}{16} - 344\frac{9}{100}$
11. $622.5 - 6.243$

196. Oral Problems.

1. Reduce $\frac{1}{8}$ to a decimal.
2. Express the decimal $.3\frac{1}{2}$ as a simple fraction.
3. What decimal of a ton is 125 pounds?
4. One hundred fifty marbles are divided among a certain number of boys. Each receives 12 and there are 6 remaining. How many boys are there?
5. Express the decimal $.62\frac{1}{2}$ as a simple fraction.
6. What decimal of a peck is 7 quarts?
7. If 8 men can do a piece of work in 6 days, in how many days can 4 men do it?
8. If Maria spends \$.75 a day, in how many days will she spend \$9?
9. If you had $3\frac{1}{2}$ oranges to divide among your friends, giving each $\frac{1}{4}$ of an orange, to how many friends would you give?
10. $\frac{1}{4}$ of 14 is $\frac{1}{2}$ of what number?
11. Change .75 yards to feet and inches.
12. At $16\frac{2}{3}$ ¢ a yard, what will 12 yards of ribbon cost?
13. At 80¢ a pound, what do 4 ounces of tea cost?
14. If I have 12 yards of ribbon, to how many girls can I give $\frac{1}{4}$ of a yard each?
15. A boy lives $10\frac{1}{2}$ rods from his school. How far does he walk in a day to attend two sessions of school?

197. Written Problems.

1. In the written number 54,372, the value expressed by the 5 is how many times the value expressed by the 2?
2. Find the sum of two and twenty-five thousandths, five and twenty-seven ten-thousandths, forty-seven and one hundred twenty-six millionths, one hundred fifty and seven ten-millionths.

3. In a mass of alloy weighing 291.42685 pounds, there were found 40.0921 pounds of silver, 160.09090 pounds of copper, 22.002 pounds of iron, and .426900 pounds of zinc. The remainder was lead. What was the weight of the lead?

4. How many bushels of oats at $\frac{3}{4}$ of a dollar a bushel will pay for $\frac{5}{6}$ of a barrel of flour at \$5.40 a barrel?

5. Add 3.684; 19.5; .00875; 15,863.625; 8.7; and 100.4875.

6. Change to a common fraction in its lowest terms .009375. Change $\frac{8}{54}$ to a decimal.

7. If $\frac{3}{4}$ pound of tea costs $\$ \frac{1}{2}$, how many pounds can be bought for \$7.50?

8. Change to common fractions .0075 and .625.

9. Change to decimals $\frac{5}{15}$, $\frac{9}{25}$, and $5\frac{7}{8}$, and add the results.

10. Reduce to common fractions, and then find the sum of the common fractions: $.12\frac{1}{2}$, $.3\frac{1}{3}$, $.16\frac{2}{3}$.

11. Add three hundred seventy-six ten-thousandths, forty-five hundred-thousandths, five hundred sixty-eight thousandths, fourteen and fifteen hundredths.

12. At 24 cents per gallon, what will be the cost of 16 gal. 3 qt. of milk?

MULTIPLICATION OF DECIMALS.

198. Give answers in decimals:

1. Multiply .000486 by 29.5.

Place the units' figure (9) of the multiplier under the last figure (6) of the multiplicand. 486 millionths multiplied by 2 tens gives a product of 972 hundred-thousandths, or .00972; place the right-hand figure (2) of this product under the 2 of the multiplier, etc.

The result, .0143370, contains seven decimal places, which is equal to the six in the multiplicand plus the one in the multiplier. Rejecting the unnecessary cipher at the right, the product is .014337, *Ans.*

$$\begin{array}{r}
 .000486 \\
 \times 29.5 \\
 \hline
 .00972 \\
 + 4374 \\
 \hline
 2430 \\
 \hline
 .0143370
 \end{array}$$

2. Multiply 29.5 by .000486.

$$\begin{array}{r}
 29.5 \\
 \times 0.000486 \\
 \hline
 .01180 \\
 2360 \\
 \hline
 .0143370
 \end{array}$$

The units' figure of the multiplier may be considered as zero.

Ans. .014337.

Multiply as in whole numbers, and from the right of the product point off as many decimal places as there are decimal places in both factors.

Multiply:

1. 24.75×3.02

6. $1.876 \times 3\frac{3}{4}$

2. $98\frac{1}{5} \times 0.00046$

7. 3.48×4.8665

3. $148\frac{1}{40} \times 12.5$

8. $.43\frac{1}{4} \times 1\frac{1}{16}$

4. $380\frac{1}{2} \times .012$

9. $192.38 \times .238$

5. $.09375 \times 1.48$

10. $26.4 \times .016$

DIVISION OF DECIMALS.

199. 1. Divide 7.345 by .29.

$$\begin{array}{r}
 25.327 \\
 ,29)7,34.500 \\
 \underline{58} \\
 154 \\
 \underline{145} \\
 95 \\
 \underline{87} \\
 80 \\
 \underline{58} \\
 220 \\
 \underline{203} \\
 17
 \end{array}$$

Make the divisor a whole number by moving the decimal point two places to the right, which multiplies the divisor by 100; and make a corresponding change in the dividend. Dividing 734.5 by 29 gives a quotient of 25.3275+. Since the quotient is to be limited to three decimal places, 8 followed by a minus sign is substituted for the 7, to indicate that the fourth decimal figure is at least 5.

Ans. 25.328 -

2. Divide 753 by 4.18.

180.143

$$\begin{array}{r} 4.18.)753,00.000 \\ \underline{418} \end{array}$$

Removing the decimal point in the divisor two places to the right multiplies the divisor by 100. Annex two ciphers to the dividend.

As the fourth decimal figure in the quotient is greater than 5, the 3 is changed to a 4, followed by a minus sign.

Ans. 180.144 -

$$\begin{array}{r} 3350 \\ 3344 \\ \hline 60.0 \\ 41.8 \\ \hline 18.20 \\ 16\ 72 \\ \hline 1\ 480 \\ 1\ 254 \\ \hline 226 \end{array}$$

3. Divide .8756 by 4326.

Ans. .0002024 +

The decimal point in the quotient is placed over the new decimal point in the dividend, the necessary decimal ciphers being supplied. A + sign is placed after the last quotient figure to show that the next quotient figure is less than 5.

$$\begin{array}{r} 4326).8756000 \\ \underline{8652} \\ 10400 \\ 8652 \\ \hline 17480 \\ 17304 \\ \hline 176 \end{array}$$

Make the divisor a whole number by removing the decimal point, and make a corresponding change in the dividend. The number of decimal places in the quotient will be equal to the number in the dividend as changed.

200. Written Exercises.

Divide:

- | | |
|-------------------|--------------------|
| 1. 4.054 + 18.25 | 10. 62.478 + 4279 |
| 2. 123.5 + 384 | 11. 346.25 + 64.8 |
| 3. 471 + 5.325 | 12. 9.1342 + 208.3 |
| 4. .3126 + .0134 | 13. 1784 + 29.57 |
| 5. 12.345 + .0047 | 14. 343.71 + 1.127 |
| 6. .8756 + 4.322 | 15. 83.087 + 5.37 |
| 7. 8 + 122 | 16. 137.84 + 7.91 |
| 8. .3678 + .9125 | 17. 38.9008 + .523 |
| 9. 48.45 + .089 | 18. .81074 + .0091 |

201. Solve by short division:

1. Divide 18.756 by 3000.

Cancel the ciphers in the divisor, thereby dividing it by 1000. Move the decimal point in the dividend three places to the left, which divides it by 1000. Place the decimal point in the quotient under the new decimal point in the dividend.

$$\begin{array}{r} 3000 \) .018756 \\ \underline{\quad\quad\quad} \\ .006252 \end{array}$$

Ans.

- | | |
|-----------------------|--------------------------|
| 2. $48.36 \div 4000$ | 11. $48.64 \div 200$ |
| 3. $.4824 \div 12000$ | 12. $.00531 \div 90000$ |
| 4. $11.011 \div 700$ | 13. $96.51 \div 60$ |
| 5. $3.6504 \div 90$ | 14. $87.5 \div 500$ |
| 6. $45.63 \div 1500$ | 15. $183.275 \div 10000$ |
| 7. $130.13 \div 1100$ | 16. $1.7632 \div 1600$ |
| 8. $.8712 \div 60$ | 17. $1.5639 \div 130$ |
| 9. $3.075 \div 5000$ | 18. $614.4 \div 120$ |
| 10. $.07056 \div 140$ | 19. $.8008 \div 7000$ |

202. Perform indicated operations.

Change the divisor to a whole number, making corresponding change in the dividend. Cancel.

$$1. \frac{34.2 \times .875}{\cancel{125}} = 239.4$$

$$2. \frac{249 \times 3.92}{.098}$$

$$3. \frac{.083 \times .72}{288}$$

$$4. \frac{.6876 \times .27}{.081}$$

$$5. \frac{234 \times .001}{\cancel{98} \cancel{6} \times \cancel{18} \cancel{2}} = .234$$

$$6. \frac{3.1416 \times 2.3}{.7854}$$

$$7. \frac{7.72 \times 65}{19.3}$$

$$8. \frac{450 \times 23.8}{1.19}$$

$$9. \frac{34.3 \times 8.1}{.49 \times 100}$$

$$11. \frac{2.75 \times .801}{1.1 \times 6}$$

$$10. \frac{.576 \times 6.3}{14.4 \times 25}$$

$$12. \frac{.306 \times 8.75}{.9 \times 68}$$

203. Reduce to common fractions — lowest terms.

1. Reduce $.3\frac{1}{2}$ to a common fraction — lowest terms.

$.3\frac{1}{2}$ is a complex decimal; that is, a decimal and a common fraction written together. It may be written as the complex fraction $\frac{3\frac{1}{2}}{10}$, which means $3\frac{1}{2} + 10$.

$$3\frac{1}{2} + 10 = \frac{7}{2} \times \frac{1}{10} = \frac{7}{20}, \text{ Ans.}$$

Note. — A complex fraction is one which has a fraction in the numerator or in the denominator or in both.

2. Reduce $.006\frac{1}{4}$ to a common fraction — lowest terms.

$$.006\frac{1}{4} = .00625 = \frac{625}{100000};$$

dividing both terms by 25, we get $\frac{25}{4000}$;

dividing both terms by 25, we get $\frac{1}{160}$, *Ans.*

$$3. .33\frac{1}{3}$$

$$6. .01\frac{1}{3}$$

$$9. .04\frac{1}{3}$$

$$4. .16\frac{2}{3}$$

$$7. .06\frac{2}{3}$$

$$10. .76\frac{1}{3}$$

$$5. .142\frac{1}{3}$$

$$8. .833\frac{1}{3}$$

$$11. .037\frac{1}{3}$$

204. Oral Exercises.

1. Divide 6 by .03.
2. $\frac{1}{4}$ is what part of 2?
3. What is the product of one hundred by one-hundredth?
4. Subtract 25 thousandths from 5.
5. What will 150 pounds of coffee cost at the rate of 3 pounds for 50 cents?
6. What will be the cost of 3 pecks of cherries at 2 cents a pint?

7. Divide $\frac{2}{3}$ by $\frac{5}{6}$.
8. At 3 oranges for 5 cents, what will be the cost of 4 dozen oranges?
9. If a man walks $\frac{7}{12}$ of a mile in 10 minutes, how far can he walk in an hour and a half?
10. A woman bought 12 yards of cloth at 70¢ a yard; she paid \$5 in cash, and the rest in butter at 20¢ a pound. How many pounds of butter did she give?

205. Written Exercises.

1. Divide the sum of .736 and 1.2854 by their difference.
2. Divide .1 by .2, and .35 by 35, and find the product of the quotients.
3. Reduce $\frac{7}{5120}$ to a decimal, and divide it by .3125.
4. Divide .12096 by .032.
5. Multiply .00273 by 3000.456, and divide the product by .08.
6. Divide 12.3125 by .000625.
7. Divide 51.5 by 412, and 412 by 51.5.
8. Multiply 31.5 by 27.9, and divide the product by 9.765.
9. Reduce $\frac{4.25}{3 + \frac{1}{8}}$.
10. Find the value of $\frac{.0021 \times 3.004}{.024}$.
11. What will be the duty on 175 kilograms of wool at 33 cents per pound? (1 kilogram = 2.2046 pounds.)
12. How much is the fraction $\frac{2}{3}$ increased or diminished when 2 is added to each of its terms (numerator and denominator)?

Chapter Three.

13. Find the cost of 360 meters of cloth at \$1.10 per yard (1 meter = 39.37 inches).
14. Find the cost in United States money of 386 hats at 24 francs each (1 franc = 19.3 cents).
15. Find the cost in United States money of 480 meters of cloth at 1.10 marks per meter (1 mark = 23.8 cents).
16. A merchant bought 30 pieces of cloth, each containing 41.6 yards, for \$3.875 per yard, and 25 pieces of 36.8 yards each, for \$4.125 per yard. He sold the entire lot for \$3.96 per yard. How much did he gain or lose?
17. An importer received a box of chemicals weighing 122 grams, each gram containing 15.432 English grains, on which he paid a duty of \$.05 per grain. What was the amount of duty?
18. A dealer exported 374.319 bushels of corn, receiving in exchange coal at the rate of 1 ton of coal for 15.124 bushels of corn. How much coal did he receive?
19. .75 is what part of 3.25?
20. Reduce .005025 to a common fraction.

UNITED STATES MONEY.

206. Written Exercises.

1. Find the cost of 24,400 bricks @ \$6.25 per M.
M means 1000. $24,400 = 24.4 \text{ M}$. Since the cost per thousand is \$6.25, 24.4 thousand will cost 24.4 times \$6.25.
2. 760 pounds of hay @ 95 cents per cwt. (100 pounds)
 $(\$.95 \times 7.6)$
3. 48,600 laths @ \$2.80 per M.
4. 39,250 stamped envelopes @ \$21.30 per thousand.
5. 1875 pounds of straw @ 68 cents per cwt.

6. 108,745 Philadelphia bricks @ \$22 per M.
7. 14,860 oranges @ 75¢ per hundred.
8. 2376 eggs @ 13½¢ per dozen.
9. 4500 cigars @ \$35 per M.
10. 28 dozen wax candles @ \$13.50 per gross (144).

Solve by cancellation where possible :

11. 38,648 pounds of wheat @ 90¢ per bushel (60 pounds).

Since there are 60 pounds in a bushel, 38,648 pounds =

$$\frac{38648}{60} \text{ bushels. At } 90 \text{ cents per bushel, the cost is } \frac{\$.90 \times 38648}{60}, \text{ etc.}$$

NOTE. — In cancelling, be careful not to strike out a cipher in 60 and one in .90, without inserting a decimal cipher.

12. 18,964 pounds of coal @ \$5 per ton (2000 pounds).
13. 48,576 pounds of oats @ 36¢ per bushel (32 pounds).
14. 69,104 pounds of rye @ 91½¢ per bushel (56 pounds).
15. 74,816 pounds of corn @ 48½¢ per bushel (56 pounds).

DENOMINATE NUMBERS.

207. Written Exercises.

1. Change 12 pounds and 9 ounces to ounces.

Since there are 16 ounces in 1 pound, in 12 pounds there are 12 times 16 ounces, or 192 ounces. In 12 pounds 9 ounces, there are 192 ounces + 9 ounces, or 201 ounces.

The work may be arranged in this way. Above the ounces, write the number of ounces in a pound, viz. 16. Multiply 16 ounces by 12, adding in the 9 ounces.

$$\begin{array}{r}
 & 16 \text{ oz.} \\
 12 \text{ lb.} & 9 \text{ oz.} \\
 \hline
 & 201 \text{ oz.}
 \end{array}$$

Ans. 201 oz.

Change:

1. 20 rods and 3 yards to yards.
2. 2 miles to yards.
3. 3 days and 17 hours to hours.
4. 24 minutes and 15 seconds to seconds.
5. 8 tons and 1675 pounds to pounds.
6. 43 gallons and 8 quarts to quarts.
7. 75 gallons to pints.
8. 19 bushels and 3 pecks to pecks.
9. .03125 ton to pounds and ounces.
10. $\frac{7}{8}$ yard to feet and inches.

208. Written Exercises.

Change:

1. 975 ounces to pounds and ounces.
2. 396 inches to yards.
3. 517 hours to days and hours.
4. 1694 seconds to minutes and seconds.
5. 9314 pounds to tons and pounds.
6. 987 pints to gallons, quarts, and pinta.
7. 1485 quarts to pecks and quarts.
8. 185 pecks to bushels and pecks.
9. 840 hours to weeks.
10. 12 hours to the fraction of a week.
11. 28 inches to the fraction of a yard.
12. 10 ounces to the decimal of a pound.
13. 3 quarts to the decimal of a bushel.

209. Written Exercises.

Add:

1. 13 lb. 6 oz. $10 \text{ oz.} + 9 \text{ oz.} + 6 \text{ oz.} = 25 \text{ oz.} = 1 \text{ lb. } 9 \text{ oz.}$
 5 lb. 9 oz. Write 9 ounces and carry 1 to column of
25 lb. 10 oz. pounds. *Ans.* 44 lb. 9 oz.
2. 19 yd. 1 ft. 6. 11 bu. 3 pk.
 2 ft. 6 bu. 2 pk.
3 yd. 1 ft. 2 pk.
3. 5 min. 30 sec. 7. 1 pk. 6 qt.
 11 min. 25 sec. 1 pk. 7 qt.
9 min. 18 sec. 5 qt.
4. 4 ft. 9 in. 8. 3 wk. 5 da.
 2 ft. 6 in. 6 wk. 6 da.
7 ft. 7 in. 1 wk. 3 da.
5. 18 gal. 3 qt. 9. 11 T. 165 lb.
 9 gal. 1 qt. 4 T. 983 lb.
2 qt. 1756 lb.

210. Subtract:

1. 8 lb. Change 8 lb. to 7 lb. 16 oz.
4 lb. 7 oz. $16 \text{ oz.} - 7 \text{ oz.} = 9 \text{ oz.}$
 $7 \text{ lb.} - 4 \text{ lb.} = 3 \text{ lb.}$ *Ans.* 3 lb. 9 oz.
2. 15 yd. 1 ft. 6. 89 bu. 2 pk.
9 yd. 2 ft. 67 bu. 3 pk.
3. 17 hr. 7. 3 pk. 2 qt.
9 hr. 50 min. 2 pk. 7 qt.
4. 1 yd. 1 ft. 1 in. 8. 11 wk. 1 da.
2 ft. 9 in. 9 wk. 5 da.
5. 25 gal. 1 qt. 9. 5 T. 896 lb.
6 gal. 3 qt. 1984 lb.

211. Multiply:

1. 12 lb. 7 oz. \times 3

3 times 7 ounces are 21 ounces, or 1 pound 5 ounces. Write 5 ounces. 3 times 12 pounds are 36 pounds, and 1 pound to carry are 37 pounds.

Ans. 37 lb. 5 oz.

2. 3 hr. 10 min. \times 7

7. 7 min. 18 sec. \times 10

3. 4 T. 985 lb. \times 11

8. 9 gal. 3 qt. \times 2

4. 7 bu. 3 pk. \times 9

9. 2 ft. 9 in. \times 8

5. 3 wk. 4 da. \times 4

10. 1 yd. 1 ft. 6 in. \times 6

6. 4 yd. 1 ft. \times 5

11. 3 yr. 4 mo. \times 7

212. Divide:

1. 9 lb. 2 oz. \div 2

$\frac{1}{2}$ of 9 pounds is 4 pounds and 1 pound remainder, or 16 ounces. Add to this 2 ounces, giving 18 ounces for the dividend. $\frac{1}{2}$ of 18 ounces is 9 ounces.

Ans. 4 lb. 9 oz.

2. 31 gal. 2 qt. \div 9

7. 19 ft. 2 in. \div 10

3. 19 hr. 21 min. \div 3

8. 34 T. 936 lb. \div 4

4. 26 bu. 1 pk. \div 5

9. 17 wk. 1 da. \div 6

5. 41 min. 44 sec. \div 8

10. 52 yd. 0 ft. 9 in. \div 11

6. 18 yd. 2 ft. \div 7

11. 23 yr. 4 mo. \div 7

213. Divide:

1. 18 lb. 4 oz. by 4 lb. 9 oz.

18 lb. 4 oz. = 292 oz.

4 lb. 9 oz. = 73 oz.

292 oz. \div 73 oz. = 4, *Ans.*

NOTE.—Change the divisor and the dividend to the same denomination. The answer is an abstract number.

2. 16 yd. by 2 yd. 2 ft.
3. 51 hr. 36 min. by 6 hr. 27 min.
4. 47 min. 42 sec. by 5 min. 18 sec.
5. 84 yr. 7 mo. by 12 yr. 1 mo.
6. 19 da. 3 hr. by 2 da. 3 hr.
7. 3 mi. 40 rd. by 125 rd.
8. 103 T. 808 lb. by 8 T. 1234 lb.
9. 52 gal. 2 qt. by 3 gal. 2 qt.
10. 68 bu. 1 pk. by 5 bu. 1 pk.
11. 30 ft. 8 in. by 1 ft. 11 in.
12. 52 yd. 9 in. by 4 yd. 2 ft. 3 in.
13. 51 wk. 3 da. by 2 wk. 6 da.

214. Oral Problems.

1. What will be the weight of 16 hams that average 10 lb. 5 oz. each?
2. From a chest of tea containing 54 pounds there were sold 27 lb. 7 oz. How many pounds remain?
3. Seven bushels of potatoes are divided among 8 persons. How many pecks and quarts does each receive?
4. How many square inches in the surface of a sheet of paper measuring 11 $\frac{1}{2}$ inches by 13 inches?
5. How many feet and inches in $\frac{4}{5}$ yard?
6. What decimal of a pound is 14 ounces?
7. A man buys a bushel of hickory nuts. After he sells 2 pk. 4 qt., what fraction of the bushel has he left?
8. A dealer puts 30 gallons of milk in cans holding 1 qt. 1 pt. each. How many cans does he fill?
9. At \$24 per month, how much rent will a man pay in 1 year and 5 months?

10. 75 hundredths of a pound is how many ounces?
11. How many feet in 5 rods?
12. 7 qt. 1 pt. of milk is divided among 5 people. How many quarts and pints does each receive?
13. What fraction of 2 lb. 3 oz. is 1 lb. 4 oz.?
14. Three-eighths of a ton is how many pounds?
15. Change 9 hr. 36 min. to the fraction of a day.

215. Written Problems.

1. 32 hams weigh 464 pounds. What is the average weight?
2. 595 gallons of oil are put into 14 barrels. How many gallons and quarts does each contain?
3. If there are 42 gallons and 2 quarts in a barrel of oil, how much oil will there be in 15 barrels?
4. A piece of cloth containing 57 yards is divided equally among six persons. What is the length of each one's share?
5. How many minutes in a day?
6. July 1 is the last school day. How many days' vacation will there be, if school begins September 6?
7. How many hours and minutes are there from half-past 3 Saturday afternoon to a quarter before 9 Monday morning?
8. How many steps, 2 ft. 6 in. long, must a man take in walking 1200 feet?
9. A man owns a plot of ground 420 feet long, 240 feet wide. How many rods of fence will be required to enclose it?
10. A train goes from Jersey City to Washington, 228 miles, in 4 hr. 12 min. How many miles an hour does it travel? How long does it take the train to go one mile?

11. On Monday a boarding-house uses 3 gallons 2 quarts of milk; on Tuesday, 4 gallons; on Wednesday, 3 gallons 1 quart; on Thursday, 4 gallons 2 quarts; on Friday, 6 gallons; on Saturday, 5 gallons 2 quarts; on Sunday, 3 gallons. How much is used during the week, and what is the average per day?

12. June 21 the sun rises at New York at 4.23 A.M. and sets at 7.40 P.M. How long is the night?

13. From $3\frac{1}{4}$ bushels take 3 pecks.

14. What is the number of rods in the perimeter of a field 206 ft. 3 in. wide and twice as long?

MEASUREMENTS.

216. Written Exercises.

How many *square inches* in each of the following rectangles? First change each dimension to inches.

1. 42 in. by 36 in.

6. 9 ft. by 11 ft.

2. 71 in. by 18 in.

7. 27 in. by 30 in.

3. 3 ft. 1 in. by 4 ft. 2 in.

8. 65 in. by 92 in.

NOTE.—37 in. by 50 in.

9. 7 ft. 3 in. by 2 yd.

4. 5 ft. 3 in. by 6 ft. 4 in.

10. 3 yd. by 6 ft. 6 in.

5. 12 ft. by 18 ft.

(108 in. by 78 in.)

217. How many *square feet* in each of the following rectangles? First change each dimension to feet, or to feet and a fraction.

11. 18 ft. by 24 ft.

15. $3\frac{1}{2}$ ft. by 4 ft.

12. 36 in. by 4 ft.

16. 3 ft. by $1\frac{1}{2}$ yd.

(3 ft. by 4 ft.)

17. 42 in. by 4 ft.

13. 6 yd. by 8 yd.

18. 25 ft. by 17 ft. 6 in.

(18 ft. by 24 ft.)

19. 42 in. by 48 in.

14. 1 yd. by 48 in.

20. 13 yd. by 15 yd.

218. How many *square yards* in each of the following rectangles? Change each dimension to yards, or to yards and a fraction.

- | | |
|---------------------------|----------------------------|
| 21. 18 yd. by 25 yd. | 26. 36 yd. by 24 in. |
| 22. 15 yd. by 1 yd. 1 ft. | 27. 17 ft. 6 in. by 32 in. |
| 23. 27 ft. by 36 ft. | 28. 22 ft. 9 in. by 18 in. |
| 24. 54 ft. by 2 ft. 6 in. | 29. 108 in. by 90 in. |
| 25. 24 yd. by 27 in. | 30. 180 ft. by 54 in. |

219. Oral Exercises.

1. If a table is 3 yards long and 2 yards wide, how many square feet in it?

2. If it takes 24 yards of carpet, a yard wide, to cover a floor, how many yards $\frac{1}{4}$ yard wide will be needed for the same floor?

3. How many square inches in $\frac{1}{4}$ of a square foot?

4. A room is 21 feet long and 18 feet wide. What will it cost, at 5 cents per yard, for a strip of moulding around the walls?

5. How many square yards of carpet would be needed for the floor of the above room?

6. A field is 40 rods long and 26 rods wide. What is the distance around it?

7. What will it cost to carpet a room 18 feet long, 15 feet wide, at 75 cents per square yard?

8. What is the cost of fencing a lot 24 rods long by 20 rods wide, at \$1.12 $\frac{1}{2}$ per rod?

9. My field is 100 rods long and 75 rods wide. How much is it worth at \$2 a square rod? How much will it cost to fence it at \$1 a rod?

10. How many yards of fence will be required to enclose a rectangular field 98 yards long and 50 yards wide?

220. Written Problems.

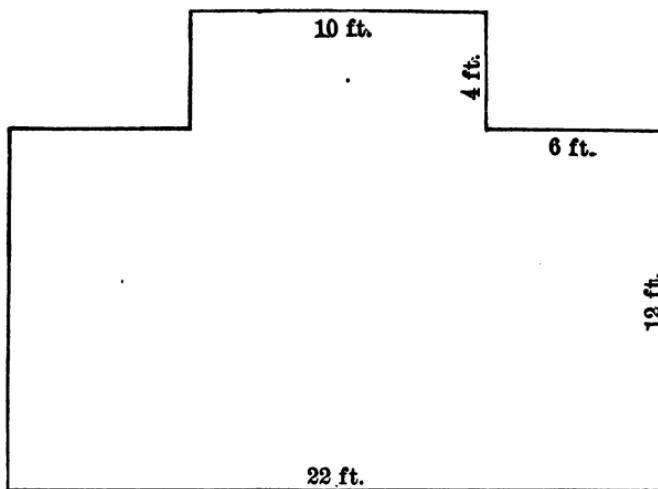
Make a diagram in each case:

1. A lot 25 feet by 100 feet has on it a house 25 feet by 55 feet. How many square feet are there left for a yard?
2. How many square feet are there in the floor of a room 24 feet long, 18 feet wide?
3. How many square yards are there in the ceiling of the same room?
4. Find the number of square yards of plastering needed for the end wall of a room 18 feet wide, 9 feet high, after deducting for two windows each 6 feet high, $4\frac{1}{2}$ feet wide.
5. How many square yards of plastering will be needed for the opposite wall of the same room, 18 feet wide, 9 feet high, after deducting for a door $7\frac{1}{2}$ feet high, 6 feet wide?
6. Calculate the number of square yards of plastering needed for two side walls of a room 24 feet long, 9 feet high, after deducting for a fireplace 6 feet square on one side.
7. A house 30 feet by 60 feet, with an addition 15 feet square, is built upon a lot 100 feet square. How many square feet of ground are covered by the building? How many square feet remain for a garden?
8. Measure the top of a brick and calculate the number of square inches in its surface. How many square inches in the surface of the bottom of the brick? Measure one side, and calculate its surface. How many square inches are there in the surface of the opposite side? How many square inches in each end?
9. Measure a crayon box, and calculate the number of square inches in each face.

Chapter Three.

10. Calculate the number of square feet in the floor of the classroom. In the ceiling. In each side wall. In each end wall.

11. What will it cost to put moulding around a room shaped like the drawing, allowing 3 inches on every corner for matching, the moulding being worth $5\frac{1}{4}$ ¢ a foot?



12. The circumference of a circle is 3.1416 times the diameter. What is the diameter of a circular track 1760 yards in circumference? Find to two places of decimals.

13. Show the difference between 2 square inches and 2 inches square.

14. How many paving tiles 6 inches square are needed to cover a floor 18 feet long, 10 feet wide?

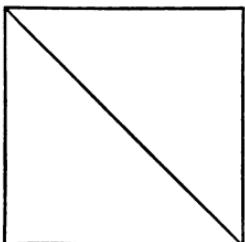
15. How many flagstones, each 4 feet long and 2 feet wide, will be needed to lay a crossing 32 feet long and 6 feet wide? What will be the cost of them at the rate of \$ 50 for 100 stones?

AREAS OF RIGHT-ANGLED TRIANGLES.

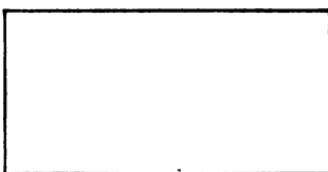
221. Preliminary Exercises.

The square shown in the diagram is divided into two parts by a diagonal. One side of the square measures 10 feet.

1. Mark in each triangle its area.



Square.

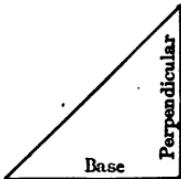


Rectangle.

2. Divide a rectangle 20 feet by 12 feet into two parts by a diagonal. Mark in each triangle its area.

3. Draw a right-angled triangle 3 inches by 4 inches. Calculate its area in square inches.

4. How many square yards in the surface of a right-angled triangle whose base measures 30 feet, and whose perpendicular measures $22\frac{1}{2}$ feet?



222. Written Exercises.

Find the area in *square feet* of the following right-angled triangles. (Change each dimension to feet.)

1. Base 20 yards, perpendicular 30 feet.

$$\text{Area} = 1 \text{ square foot} \times \frac{1}{2} (60 \times 30) = 900 \text{ square feet, Ans.}$$

The number of square feet in the area of a right-angled triangle is equal to one-half the product of the number of feet in the base by the number of feet in the perpendicular.

Chapter Three.

2. Base 16 inches, perpendicular 3 feet.
3. Base 30 inches, perpendicular 1 yard.
4. Base 3 feet 6 inches, perpendicular 5 feet.
5. Base 2 yards 1 foot, perpendicular 1 yard 9 inches.
6. Base 50 yards, perpendicular 36 yards.
7. Base $112\frac{1}{2}$ feet, perpendicular 30 yards.
8. Base 90 inches, perpendicular 2 feet.
9. Base $12\frac{1}{2}$ yards, perpendicular $13\frac{1}{2}$ yards.
10. Base 1 rod, perpendicular $7\frac{1}{2}$ feet.
11. Base $33\frac{1}{2}$ feet, perpendicular 18 feet 6 inches.

BILLS.**223.**

PHILADELPHIA, Sept. 24, 1905.

MR. WILLIAM J. HURLEY,

To JOHN J. PETIT & SON, Dr.

	To 50 lb. Pipe	$5\frac{1}{2}\text{¢}$				
	To 3 Faucets	75¢				
	To 1 Sink		4	75		
	To $3\frac{1}{4}$ days' Labor	\$4.75				\$

1. Copy and complete the above bill.
2. Albert Janson has done $3\frac{1}{2}$ days' work, @ \$3.50 per day, for Ephraim Whitlock. He charges for 850 feet lumber, at \$2 per hundred; 5 pounds of nails, at 9¢ per pound; 3 locks, @ 50¢; 2 bolts, at 10¢. Make out his bill.
3. A gardener furnishes 3 rose bushes, at 75¢; 4 grape-vines, at 50¢; 11 fuchsias, at 30¢; 25 pansies, at 10¢. He charges \$3.25 per day for $2\frac{1}{4}$ days' labor. Make out his bill.

4. An upholsterer charges \$3 per day for repairing some furniture. He supplies 6 pounds of hair, at 50¢ per pound; 17 yards of plush, at \$1.75 per yard; 3 papers of tacks, at 10¢; cord, gimp, etc., 47¢. He works 4 days. Make out his bill.

NOTE.—The foregoing bills are for work done and materials supplied. Notice how the heading differs from those in Arts. 103 and 173.

5. Make out and receipt a bill for four articles bought to-day by John Harrigan from Metz and Fagan, grocers (Art. 103).
6. Make out a bill containing ten items bought by Mrs. A. S. Jacobs, at different times during October, 1905, from Frederick Loeser & Co., dealers in dry goods (Art. 173).
7. Make out a bill for labor done and materials furnished by Joseph Minew, gardener.

PERCENTAGE.

224. Per cent means hundredths.

Six per cent means six hundredths, $\frac{6}{100}$, or .06. It is written 6%.

225. Oral Exercises.

1. What is 6% of 200?

6% means $\frac{6}{100}$. To find 6% of 200, we multiply 200 by $\frac{6}{100}$, or $200 \times .06$. Ans. 12.

2. What is $\frac{6}{100}$ of 300?

6. 6% of 150

3. Find .06 of 400

7. 6% of 250

4. 6 per cent of 500

8. 6% of 125

5. 6% of 50

9. 6% of 75

- | | |
|---------------|-----------------------------|
| 10. 6% of 60 | 16. $\frac{1}{2}\%$ of 600 |
| 11. 6% of 160 | 17. $\frac{1}{4}\%$ of 600 |
| 12. 4% of 125 | 18. $2\frac{1}{2}\%$ of 600 |
| 13. 7% of 500 | 19. $3\frac{1}{4}\%$ of 400 |
| 14. 5% of 240 | 20. $\frac{1}{8}\%$ of 400 |
| 15. 1% of 600 | 21. 9% of 90 |

In solving examples in percentage, the work is frequently shortened by changing the per cent to a common fraction in its lowest terms.

$$75\% = \frac{75}{100} = \frac{3}{4}, \text{ Ans.}$$

226. What fraction equals :

- | | | |
|----------------------|---------------------|-----------------------|
| 1. 25% | 5. 20% | 9. $6\frac{3}{4}\%$ |
| 2. $12\frac{1}{2}\%$ | 6. 50% | 10. $37\frac{1}{2}\%$ |
| 3. $33\frac{1}{3}\%$ | 7. $6\frac{1}{4}\%$ | 11. $62\frac{1}{2}\%$ |
| 4. $16\frac{2}{3}\%$ | 8. $3\frac{1}{8}\%$ | 12. $87\frac{1}{2}\%$ |

227. 1. Find 50% of 96.

$$50\% \text{ of } 96 = \frac{1}{2} \text{ of } 96 = 48, \text{ Ans.}$$

- | | |
|-----------------------------|-----------------|
| 2. 25% of 72 | 10. 150% of 140 |
| 3. $12\frac{1}{2}\%$ of 120 | 11. 250% of 140 |
| 4. $6\frac{1}{4}\%$ of 48 | 12. 125% of 140 |
| 5. $33\frac{1}{3}\%$ of 36 | 13. 1% of 140 |
| 6. $16\frac{2}{3}\%$ of 126 | 14. 1% of 350 |
| 7. $8\frac{1}{3}\%$ of 72 | 15. 2% of 350 |
| 8. 100% of 140 | 16. 3% of 350 |
| 9. 200% of 140 | 17. 4% of 350 |

228. Written Problems.

NOTE.—The pupils should find but little difficulty in solving these problems, which will serve to show a few applications of percentage. There is no need of preliminary explanation of terms the meaning of which can readily be determined from the context.

1. A merchant sells a lot of cotton for \$1872.50. He receives 2% of this amount for selling it. How much does he receive ? $\text{He receives } \$1872.50 \times .02.$
2. How much will it cost me to insure goods to the amount of \$18,760 at one per cent ?
3. A dealer imports books worth \$548.40, on which he pays duty to the government at the rate of 25%. What is the amount of the duty ?
4. Eighty per cent of a class of 55 pupils are promoted. How many are not promoted ?
5. A man buys a house for \$16,000 and sells it at an advance of 3 per cent over the cost. How much does he gain ?
6. A clerk spends for rent 18 per cent of his income of \$1850 per year. What rent does he pay ?
7. A girl spelled correctly 95 per cent of 60 words. How many did she miss ?
8. Tea costing 40 cents per pound is sold at a profit of 50 per cent. What is the selling price ?
9. I loan \$600 at 6% interest per year. How much interest should I receive from January 1, 1903, to January 1, 1905 ?
10. I loan a person \$600 on July 1, 1903. He agrees to pay me 5% of the amount loaned per year as interest. How much interest should I receive July 1, 1904 ?
11. A house is valued at \$6000. How much taxes must the owner pay at the rate of \$1.25 per \$100 valuation ?

INTEREST.

229. Oral Exercises.

NOTE.—A preliminary talk with the class should develop the fact that a person hiring a horse is charged for its use, say so much an hour; that a person hiring a house is charged so much a month or a year for its use. A person borrowing money is also charged for the use of money. As the sum charged for the rent depends upon the size and value of the house, so the sum charged for the use of money depends upon the sum loaned.

A charge for use of money is called *interest*. The sum on which the interest is paid is called the *principal*. The price or *rate* is a certain per cent for a year.

1. What will be the interest on \$ 100 for 1 year at 4%?

$$\$100 \times .04 = \$4, \text{ Ans.}$$

2. On \$ 200 for a year at 5%?
3. On \$ 300 for a year at 6%?
4. On \$ 400 for a year at 7%?
5. On \$ 250 for a year at 4%?

At 4% per year, what will be the interest:

6. On \$ 200 for 1 year?
7. On \$ 300 for 2 years?
8. On \$ 100 for 3 years?
9. On \$ 200 for $1\frac{1}{2}$ years?
10. On \$ 200 for 1 year 6 months?
11. What will be the interest on \$ 200 for 3 years at 5%?

The interest for 1 year will be $\$200 \times .05$, or \$ 10; for three years it will be 3 times \$ 10, or \$ 30, *Ans.*

12. On \$ 300 for 2 years at 6%?
13. On \$ 400 for 6 years at 3%?
14. On \$ 100 for 5 years at 7%?

15. On \$ 250 for 2 years at 4% ?
16. On \$ 100 for 1 year 6 months at 6% ?
17. On \$ 200 for 3 months at 4% ?

At 4% per year, what will be the interest:

18. On \$ 200 for 6 months ?
\$ 200 \times .04 \times $\frac{1}{2}$.
19. On \$ 300 for 4 months ?
20. On \$ 400 for 3 months ?
21. On \$ 300 for 2 months ?
22. On \$ 150 for 1 month ?
23. Find the interest on \$ 24 for 1 year at 5%.
24. On \$ 36 for 1 year at 4%.
25. On \$ 67 for 1 year at 3%.

230. Written Exercises.

Find the yearly interest on :

1. \$ 286.50 at 4%	\$ 286.50
--------------------	-----------

Multiply the principal by the rate, 4%, written as
a decimal.

$$\frac{.04}{\$11.4600}$$

Ans. \$ 11.46.

- | | |
|-------------------------------|------------------------------------|
| 2. \$ 485 at 6% | 12. \$ 168 at $3\frac{3}{4}\%$ |
| 3. \$ 375.40 at 5% | 13. \$ 244 at $5\frac{1}{2}\%$ |
| 4. \$ 379 at 3% | 14. \$ 890 at $7\frac{3}{10}\%$ |
| 5. \$ 486 at $4\frac{1}{2}\%$ | 15. \$ 63.75 at 4% |
| 6. \$ 186.75 at 4% | 16. \$ 937.50 at 6% |
| 7. \$ 199.50 at 2% | 17. \$ 980.40 at 5% |
| 8. \$ 636 at $3\frac{1}{2}\%$ | 18. \$ 159.60 at $2\frac{1}{2}\%$ |
| 9. \$ 84.70 at 6% | 19. \$ 1357.37 at 7% |
| 10. \$ 93.25 at 8% | 20. \$ 2146.18 at $4\frac{1}{2}\%$ |
| 11. \$ 1257 at 7% | 21. \$ 369.40 at $3\frac{3}{4}\%$ |

Find the interest on :

\$ 290 for 2 years at 4%.

The interest for 1 year is \$ 290.

\$ 11.60. Multiplying by 2, we .04
get the interest for 2 years, \$ 11.60 interest for 1 year
\$ 23.20. 2

Ans. \$ 23.20 interest for 2 years

Multiply the principal by the rate expressed as hundredths, and this product by the time expressed in years and fraction of a year.

22. \$ 1400 for 3 years at $4\frac{1}{2}\%$.
23. \$ 2840 for 4 years at 5%.
24. \$ 1250 at 6% for 3 years.
25. \$ 5360 at $5\frac{1}{2}\%$ for 2 years.
26. \$ 380 at 3% for $4\frac{1}{2}$ years.
27. \$ 780 for 1 year 4 months at 6%.

NOTE.—1 year 4 months = $1\frac{1}{3}$ year.

28. \$ 2560 for 2 years 6 months at 5%.
29. \$ 1025 for 3 years 3 months at 4%.
30. \$ 1296 for 7 months at 7%.

NOTE.—7 months = $1\frac{1}{12}$ year.

31. \$ 648 for 5 months at 5%.
32. \$ 275 for 4 months at 3%.
33. \$ 1000 for 11 months at 6%.

231. Oral Problems.

1. I bought a house for \$ 4000, and sold it for 80% of the cost. For what did I sell it?
2. A merchant whose income is \$ 2000 a year spends 75% of it. How much does he save?

3. John has \$ 30 in the bank, Mary has $16\frac{2}{3}\%$ as much. How much has Mary?

4. If I buy goods for \$ 400 and sell them at a loss of 5%, how much do I lose?

5. A farmer had 100 sheep and sold 20% of them. How many did he sell?

6. Cloth shrinks 5% of its length in sponging. What is the shrinkage of a piece which contained 40 yards before sponging?

7. In a school of 400, 60% are boys. How many girls in the school?

8. What is the interest on \$ 100 for 2 years at 4%?

9. What is the interest on \$ 50 for one year at 6%?

10. What is the interest on \$ 200 for 2 years at $3\frac{1}{2}\%$?

232. Written Problems.

1. A man receives a salary of \$ 1800 a year; he pays 15% of it for board, $8\frac{1}{2}\%$ for clothing, and 16% for other expenses. What are his yearly expenses?

2. My expenses during the month of April were \$ 185.68; my expenses in May were $12\frac{1}{2}\%$ less than in April. What were my expenses in May?

3. A lawyer collected 80% of a debt of \$ 2360 and charged 5% commission on the sum collected. How much did the creditor receive?

4. A house was insured for \$ 3600 at $1\frac{1}{2}\%$. What was the cost of the insurance?

5. What is the interest on \$ 550 for 2 years 6 months at 4%?

6. What is the interest on \$ 1200 for 3 years at 5%?

7. A merchant sold goods that cost \$ 2180 at a gain of $33\frac{1}{3}\%$. How much did he receive for them?

8. What is the interest on \$720 for 1 year 6 months at 7%?
9. I bought 1260 pounds of sugar at $4\frac{1}{2}$ cents a pound and sold it at a gain of 10%. How much did I sell it for?
10. What is the interest on \$350 for 2 years at $3\frac{1}{2}\%$?

APPROXIMATIONS.

These approximation examples should not be neglected. Pupils, besides finding them useful in preventing gross errors in their calculations, will be enabled later to obtain exact results to similar examples by an extension of the methods used in obtaining approximate results. In a following chapter will be found suggestions as to the product by 99, 24, $99\frac{1}{4}$, etc.

Some pupils can probably give the exact answer to No. 5 — 96 lb. at 25¢ would be \$24; at $\frac{1}{4}$ ¢ less per lb., the cost would be 12¢ ($\frac{1}{4} \times 96$) less than \$24. The exact answers to Nos. 2, 3, 8, 9, and 10 can be obtained in a similar manner.

After the examples have been used for sight exercises in approximate answers, they should be solved for the exact answers.

SUGGESTIONS.—(1) 24 @ \$ $\frac{1}{2}$. (2) 24 @ \$125. (3) 64 @ \$ $\frac{1}{2}$.
 (4) 485 @ \$1. (11) \$27 + \$ $\frac{1}{2}$. (12) \$300 + \$1 $\frac{1}{2}$. (18) \$24 + \$ $\frac{1}{2}$.

233. Give approximate answers, at sight:

1. 23 $\frac{3}{4}$ lb. of tea @ $50\frac{1}{2}\%$.
2. 24 horses @ \$124.95.
3. 64 yd. of carpet @ $87\frac{7}{16}\%$.
4. 485 bu. of wheat @ $99\frac{1}{4}\%$.
5. 96 lb. of coffee @ $24\frac{1}{2}\%$.
6. 840 yd. of dress goods @ $33\frac{5}{16}\%$.
7. 360 yd. of oil cloth @ $66\frac{3}{4}\%$.
8. 48 cwt. of straw @ $62\frac{1}{2}\%$.
9. 92 hats @ \$1.49 $\frac{1}{4}$.
10. 128 lb. of lard @ $12\frac{1}{2}\%$.

234. Give approximate answers in whole numbers:

- | | |
|------------------------------------|------------------------------|
| 11. $\$27 + 24\frac{5}{6}\$$ | 21. 17.3×3.98765 |
| 12. $\$299.96 + \$1.49\frac{7}{8}$ | 22. $256.008 \times .249875$ |
| 13. $\$24.05 + 37\frac{9}{16}\$$ | 23. 25.1234×15.93 |
| 14. $\$15.03 + 12\frac{5}{8}\$$ | 24. 6.12×6.12 |
| 15. $\$60 + \$2.49\frac{15}{16}$ | 25. $86.4 \times .996$ |
| 16. $\$32 + 33\frac{3}{8}\$$ | 26. 33.333×5.004 |
| 17. $\$69.95 + 87\frac{1}{2}\$$ | 27. $799.387 \times .125$ |
| 18. $\$60 + 62\frac{7}{16}\$$ | 28. 7.999×7.99 |
| 19. $\$64 + 66\frac{11}{16}\$$ | 29. 7.33×11.0083 |
| 20. $\$27.95 + \1.75 | 30. $64.002 \times .3750$ |

SPECIAL DRILLS.

Note. — It is important for pupils to keep up their previous practice in handling large numbers without a pencil, and to increase the size of the numbers from year to year.

To add 185 and 89, the pupil first adds 80, then 9.

$$185 + 80 (215) + 9 = 224$$

235. Give sums:

- | | | | |
|------------------------------|-----------|-----------|-----------|
| 256 + 56 | 576 + 76 | 437 + 73 | 832 + 99 |
| 394 + 77 | 646 + 85 | 768 + 48 | 543 + 78 |
| $690 + 450 = 690 + 400 + 50$ | | | |
| 350 + 680 | 440 + 590 | 570 + 640 | 750 + 250 |
| 770 + 260 | 620 + 480 | 330 + 880 | 980 + 670 |

236. Give differences:

To subtract 56 from 312 ; first deduct 50, then 6.

$$312 - 56 = 312 - 50 (262) - 6 = 256$$

$$224 - 89 \quad 652 - 76 \quad 500 - 73 \quad 931 - 99$$

$$471 - 77 \quad 731 - 85 \quad 816 - 48 \quad 621 - 78$$

$$1200 - 610 = 1200 - 600 - 10$$

$$1140 - 690 \quad 1130 - 870 \quad 1210 - 570$$

$$1030 - 350 \quad 1100 - 620 \quad 1650 - 980$$

237. Give products:

$$98 \times 4 = 90 \times 4 (360) + 8 \times 4 (32) = 392$$

$$89 \times 5 \quad 67 \times 7 \quad 98 \times 4 \quad 79 \times 3$$

$$78 \times 6 \quad 75 \times 9 \quad 66 \times 8 \quad 89 \times 2$$

238. Oral Problems.

Note. — These problems should first be solved as sight exercises from the book. Afterward, one should be read by the teacher and the answer written by all the pupils at a given signal. These problems require no analysis. They contain numbers similar to those of the special drills on the previous page.

1. I sold 375 bushels of wheat to one miller and 87 to another. How many bushels did I sell?
2. Bought goods to the amount of \$4.29. How much change from a \$5 bill?
3. What will be the cost of 89 tons of coal at \$5 per ton?
4. If 49 hats cost \$147, what is the cost of one hat?
5. 567 marbles are divided among 9 boys. How many does each receive?
6. What will be the cost of a barrel of flour at \$5.25 and 8 pounds of sugar at 6¢?

7. How much must be paid for 55 pounds of raisins, at 8¢ per pound?
8. Find the cost of 320 pounds of hay at 60¢ per hundred pounds.
9. A father earned \$14.60, his son earned \$7.80. What were the earnings of both?
10. There are 36 inches in a yard. How many yards are there in 324 inches?
11. The product is 925, the multiplier is 25. What is the multiplicand?
12. What price was paid for 20 sheep, at \$8.75 per head?
13. A man saved \$320 per year for 5 years. How much more would he require to make \$2000?
14. Mr. Jones sold a lot for \$675, thereby losing \$85. What did he pay for it?

RATIO.**239. Written Problems.**

NOTE. — Indicate operations, and cancel where possible.

1. If 56 men can pave a street in 24 days, how long will it take 32 men to pave it?

ANALYSIS. — One man will take 56 times as long as 56 men; and 32 men will do the work in $\frac{1}{2}$ of the time required by 56 men.

Problems of this kind, involving only multiplication and division, are sometimes shortened by cancellation. Instead of multiplying 24 days by 56, and dividing the product by 32, the pupil should indicate these

$$\text{operations, then cancel : } \frac{6}{32} \frac{24 \text{ days} \times 56}{32} = 42 \text{ days, Ans.}$$

2. When a vessel sails 168 miles a day, she completes her voyage in 14 days. In what time would she complete it if she sailed 196 miles a day?

At 168 miles per day, the voyage requires 14 days.

At 196 miles per day, it would require 14 days $\times \frac{168}{196}$.

3. If a field would support 64 sheep for 21 days, how long would it support 48 sheep?

4. If 42 men could build a wall in 24 days, how many men could build it in 18 days?

The pupil must first determine what is asked. In this problem, it is the number of men. The given number of men, 42, must first be written in the multiplicand.

To build a wall in 24 days requires 42 men. To build it in a shorter time would require more men, hence the ratio is $\frac{42}{18}$.

5. If 21 horses are worth as much as 35 cows, how many horses are worth as much as 55 cows?

6. A girl that wrote 36 letters to a line, took 15 lines in writing a piece of dictation. How many lines would a girl that wrote 30 letters to a line require for the same dictation?

7. If a boy that steps 27 inches at a time takes 1000 steps in going home from school, how many steps will be taken by a boy that steps 30 inches?

8. If 1920 bricks will build a wall 15 yards long, how many bricks will be required for a similar wall 24 yards long?

9. A train going 44 miles an hour, went a certain distance in 9 hours. How long would it take a train going 36 miles an hour to make the same trip?

10. Find the cost of one-fourth of a barrel of flour at the rate of 22 cents for 7 pounds.

A barrel of flour weighs 196 pounds.

11. Six men can do a certain piece of work in eighteen days. How long would it take eighteen boys to do the same work, if one man can do as much work as two boys?
12. If a certain quantity of flour will last 48 persons 57 days, how long will it last 38 persons?

SHORT METHODS.

240. Sight Exercises.

1. 68×25	$68 \times 25 = \frac{1}{4}$ of 6800
2. 25×49	$25 \times 49 = 49 \times 25 = \frac{1}{4}$ of 49 hundred $= 12\frac{1}{4}$ hundred = 1225, Ans.
3. $88 \times 12\frac{1}{2}$	$\frac{1}{2}$ of 88 hundred
4. 24×75	13. $48 \times 37\frac{1}{2}$
5. $82 \times 12\frac{1}{2}$	14. 92×50
6. 72×25	15. $32 \times 33\frac{1}{2}$
7. 25×51	16. 88×25
8. $66 \times 33\frac{1}{2}$	17. 25×97
9. 48×75	18. $16 \times 87\frac{1}{2}$
10. $24 \times 62\frac{1}{2}$	19. $66 \times 66\frac{2}{3}$
11. 96×25	20. $16 \times 66\frac{2}{3}$
12. 25×81	21. $18 \times 16\frac{2}{3}$

241. Written Exercises.

1. 9347×25	$934700 + 4$
2. 863×75	$(86300 \times 3) + 4$
3. $8123 \times 12\frac{1}{2}$	$812300 + 8$

Dividing 8123 hundred by 8 gives a quotient of $1015\frac{3}{8}$ hundred, the fraction of which the pupil should write at once as $37\frac{1}{2}$ units without dividing out 300 units by 8. While he sets down the work in this way, $8)812300$, he should be able to write the remainder of the answer when 1015

he reaches the annexed ciphers.

4. $6483 \times 33\frac{1}{3}$	$\frac{1}{3}$ of 6483 hundred
5. 8123×125	$\frac{1}{8}$ of 8123000
6. 9347×250	14. $33\frac{1}{3} \times 3870$
7. $9347 \times 2\frac{1}{2}$	15. $66\frac{2}{3} \times 3456$
8. 9347×75	16. $16\frac{2}{3} \times 1266$
9. $6483 \times 66\frac{2}{3}$	17. $8408 \times 62\frac{1}{2}$
10. $6488 \times 37\frac{1}{2}$	18. $3875 \times 37\frac{1}{2}$
11. $4896 \times 87\frac{1}{2}$	19. $1925 \times 12\frac{1}{2}$
12. $1284 \times 62\frac{1}{2}$	20. 7314×250
13. 75×2468	21. 6480×125

242. Oral Problems.

1. What will be the cost of 49 pounds of coffee at $25\frac{1}{2}\text{¢}$ per pound?
2. I paid \$14.75 for eggs at $25\frac{1}{2}\text{¢}$ a dozen. How many dozen did I buy?
3. What will be paid for 88 bushels of wheat at $87\frac{1}{2}\text{¢}$ per bushel?
4. How many bushels of corn at $62\frac{1}{2}\text{¢}$ per bushel can be bought for \$150? ($\$150 \div \$\frac{1}{2}$)
5. How much will be paid for 99 yards of dress goods at $33\frac{1}{3}\text{¢}$ per yard?
6. How many yards of carpet at $66\frac{2}{3}\text{¢}$ per yard can be bought for \$84?
7. Find the cost of 15 dozen collars at $12\frac{1}{2}\text{¢}$ each.
8. Paid \$24 for cuffs at $16\frac{2}{3}\text{¢}$ per pair. How many dozen pairs were bought?
9. What will be the cost of 128 pounds of tea at $75\frac{1}{2}\text{¢}$ per pound?

10. A bale of cotton at $6\frac{1}{4}$ ¢ per pound cost \$25. What was the weight of the cotton?

11. A farmer sold hay at 75¢ per hundredweight, receiving for it \$39. How many hundredweights did he sell?

12. How many barrels of mess pork at \$12.50 per barrel can be bought for \$175?

13. What will be the cost of 84 yards of carpet at \$1.25 per yard?

14. When wheat sells at $1.12\frac{1}{2}$ per bushel, how many bushels can be bought for \$199?

15. At \$3.50 each, what will be paid for 42 coats?

16. Find the cost of 28 hats at \$2.75 each.

17. A real estate agent sold 97 lots at \$250 each. How much did he receive for them?

$$(\$250 = \frac{1}{4} \text{ of } \$1000)$$

18. What will be the cost of 248 horses at \$125 each?

19. At $\frac{1}{2}$ cent each, how many penholders can I buy for \$4.32?

20. Paid \$3075 for cows at \$75 each. How many were bought?

REVIEW OF FRACTIONS.

NOTE.—Practice in the sight work such as is given in the following examples will enable pupils to dispense with some of the aids they found necessary to employ during the earlier stages of work in fractions. These exercises should be answered one at a time from the book or the blackboard, preferably the latter. At a later lesson, the teacher should require the answers to five or ten examples selected promiscuously, to be written from the book or the blackboard, the examples to be announced by the teacher by number. At the same, or another lesson, the teacher should read a few, the answers to be written one at a time. In these examples pupils should not take pen or pencil until the signal is given to write the answer. No change should be made in an answer after it is written.

243. Write answers at sight:

1. Add $32\frac{1}{4}$ and $15\frac{3}{4}$.

Mentally changing the fractions to twelfths, the pupil proceeds as follows : $32\frac{1}{4} + 15(47\frac{1}{12}) + \frac{9}{12} = 47\frac{10}{12} = 48\frac{1}{12}$, Ans.

2. $24\frac{1}{2} + 15\frac{3}{4}$.

4. $62\frac{1}{2} + 23\frac{1}{4}$.

3. $50\frac{2}{3} + 20\frac{1}{2}$.

5. $40\frac{3}{4} + 33\frac{5}{6}$.

6. From $78\frac{1}{2}$ take $20\frac{3}{4}$.

SUGGESTION.— $20\frac{3}{4}$ from 78 (and $\frac{1}{2}$) leaves $57\frac{1}{2}$ (and $\frac{1}{2}$), $57\frac{1}{2} + \frac{1}{2}$,

Ans. 57\frac{7}{8}.

7. $80\frac{1}{2} - 40\frac{1}{4}$.

9. $33\frac{1}{2} - 16\frac{1}{2}$.

8. $43\frac{1}{2} - 12\frac{1}{2}$.

10. $54\frac{1}{2} - 30\frac{3}{4}$.

11. Multiply $20\frac{2}{3}$ by 6.

Six times $20(120) + 6$ times $\frac{2}{3}(4) = 124$, Ans.

12. $12\frac{2}{3} \times 8$.

14. $12\frac{2}{3} \times 9$.

13. $30\frac{2}{3} \times 10$.

15. $11\frac{1}{2} \times 6$.

16. Divide $24\frac{1}{2}$ by 2.

$\frac{1}{2}$ of $24(12) + \frac{1}{2}$ of $\frac{1}{2}(\frac{1}{2}) = 12\frac{1}{2}$, Ans.

17. $48\frac{1}{2} \div 6$.

19. $80\frac{1}{2} \div 4$.

18. $23\frac{2}{10} \div 3$.

20. $55\frac{1}{10} \div 5$.

21. Divide $24\frac{1}{2}$ by 4.

$\frac{1}{4}$ of $24(6) + \frac{1}{4}$ of $\frac{1}{2}(\frac{1}{2}) = 6\frac{1}{2}$, Ans.

22. $60\frac{1}{2} + 3$.

24. $28\frac{2}{3} + 7$.

23. $40\frac{1}{2} + 4$.

25. $36\frac{1}{2} + 9$.

26. Divide $21\frac{1}{4}$ by 5.

$21\frac{1}{4}$ contains 5, 4 times, with a remainder of $1\frac{1}{4}$, or 5 fourths.
 5 fourths $+ 5 = 1$ fourth.

Ans. 4\frac{1}{4}.

27. $17\frac{1}{2} \div 4$.

29. $26\frac{2}{3} \div 8$.

28. $19\frac{1}{2} \div 6$.

30. $19\frac{1}{2} \div 3$.

31. Divide $18\frac{1}{2}$ by 7.

$18\frac{1}{2} \div 7 = 2$, with $4\frac{1}{2}$ remainder. $\frac{1}{2}$ of $4\frac{1}{2} = \frac{1}{2}$ of $4\frac{1}{2} = \frac{1}{2} \cdot \frac{9}{2} = \frac{9}{4}$. Ans. $2\frac{9}{4}$.

32. $25\frac{1}{2} + 2$.

34. $19\frac{1}{2} + 4$.

33. $31\frac{1}{2} + 3$.

35. $22\frac{1}{2} + 5$.

244. Written Exercises.

Perform indicated operations:

1. $(1\frac{1}{2} + \frac{2}{3}) + (6\frac{2}{3} + \frac{1}{4})$

5. $52\frac{1}{2} \times (1\frac{1}{2} - \frac{1}{12})$

2. $\frac{(\frac{3}{4} \times 20) - (4\frac{1}{2} \times 2\frac{1}{4})}{\frac{1}{3} + \frac{2}{3}}$

6. $\frac{4\frac{1}{2} + 3\frac{1}{3} - 6\frac{1}{6}}{5}$

3. $\frac{16}{\frac{2}{3} \text{ of } 4\frac{1}{2}} + \frac{5\frac{1}{2}}{\frac{1}{3} \text{ of } 1\frac{1}{2}}$

7. $\frac{\frac{2}{3} \text{ of } \frac{3}{4}}{15} + \frac{\frac{2}{3} \text{ of } 2\frac{1}{2}}{8}$

4. $23\frac{3}{4} \div (3\frac{1}{3} + 1\frac{2}{3})$

8. $\frac{2}{3} \text{ of } (3\frac{1}{3} - 2\frac{1}{6} + 9\frac{1}{3})$

245. Find answers:

9. Simplify $\frac{2 + 5\frac{1}{2} - 3\frac{3}{4}}{3 + 1\frac{1}{2} - 2\frac{1}{4}}$.

10. Find the sum of $\frac{4}{5}, \frac{5}{16}, \frac{7}{20}, \frac{8}{25}, \frac{19}{400}$.

11. Reduce $\frac{1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4}}{1 + \frac{1}{2} - \frac{1}{3} - \frac{1}{4}}$ to a simple fraction.

12. Divide $(\frac{1}{2} + \frac{1}{3} + \frac{2}{5})$ by $(\frac{2}{3} \times \frac{1}{12} \times \frac{1}{15})$.

13. Simplify $\frac{1 + \frac{1}{2}}{1 - \frac{1}{2}}$ of $\frac{2}{3}$ of $\frac{1}{1\frac{1}{2}}$.

14. $\frac{7\frac{1}{2} - 3\frac{1}{4}}{7\frac{1}{2}} = ?$

15. Find the value of $\frac{4\frac{1}{2} + (\frac{2}{3} \text{ of } \frac{7}{16})}{(\frac{2}{3} \text{ of } 1\frac{1}{2}) - \frac{2}{3}}$.

16. $(2\frac{1}{2} + 1\frac{1}{3}) + (2\frac{1}{2} + 3\frac{1}{3}) = ?$

17. Find the value of $2\frac{1}{2}$ times the quotient of $(3 - 2\frac{1}{4}) + (2\frac{1}{2} - \frac{1}{3})$.

18. $3\frac{1}{2} + 14 - 7\frac{1}{2} + 5 - \frac{2}{15} = ?$

246. Multiply. Do not reduce to improper fractions.

$$\begin{array}{r} 12\frac{1}{4} \\ \times 4\frac{1}{4} \\ \hline 51 \end{array}$$

4 times $12\frac{1}{4}$ = 51; $\frac{1}{4}$ of $12\frac{1}{4}$ = $4\frac{1}{4}$.

$$\begin{array}{r} 4\frac{1}{4} \\ \hline 551\frac{1}{4} \end{array}$$

1. $18\frac{1}{2} \times 6\frac{1}{2}$
2. $25\frac{5}{8} \times 8\frac{1}{5}$
3. $16\frac{4}{5} \times 5\frac{1}{4}$
4. $36\frac{1}{4} \times 9\frac{1}{5}$
5. $22\frac{5}{8} \times 6\frac{1}{15}$

6. $16\frac{3}{7} \times 7\frac{1}{3}$
7. $48\frac{3}{4} \times 12\frac{1}{8}$
8. $37\frac{3}{5} \times 10\frac{1}{3}$
9. $36\frac{5}{6} \times 9\frac{1}{3}$
10. $32\frac{3}{8} \times 8\frac{1}{7}$

247. Oral Review Problems.

1. What per cent does a boy receive if he solves 16 examples of the 20 given out?
2. What is the interest on \$200 at 4% for 2 years?
3. If $2\frac{3}{4}$ yards of calico cost 22 cents, how many yards can be bought for 60¢?
4. How old, Dec. 1, 1904, was a boy born Sept. 1, 1891?
5. What is the cost of 3500 bricks at \$6 per M?
6. How many sheep, at \$5 each, should be given in exchange for 12 horses, worth \$200 each?
7. 75 men can do a certain piece of work in 9 days. How long will it take 45 men to do the same work?
8. If 4 barrels of oil each containing 42 gallons are emptied into a tank of 200 gallons' capacity, how many more gallons will the tank hold?
9. Change .375 yard to feet and inches.
10. How many half-pints in 2 gal. 1 qt.?
11. How many eggs in 15 dozen and 6 eggs?

12. $\frac{4}{7}$ = how many 98ths ?
13. Find the greatest common divisor of 12, 18, 27.
14. Find the least common multiple of 8, 9, 12.
15. How many yards in 5 pieces of cloth, each containing $12\frac{3}{4}$ yards ?
16. Divide $29\frac{1}{2}$ by 7.
17. When silk is 75¢ per yard, how many yards can be bought for \$9.75?
18. If $2\frac{1}{2}$ yards ribbon cost 42 cents, what will $3\frac{1}{4}$ yards cost?
19. If eggs are sold at the rate of 18 for 25 cents, what will be the cost of 6 dozen eggs?
20. Three men require 22 days to do a certain piece of work. How long would it take 11 men to do the same work ?
21. A farmer divides his farm of 425 acres into fields of $12\frac{1}{2}$ acres each. How many fields has he?
22. What will be the cost of 46 tons of hay, at $\$12\frac{1}{2}$ per ton ?
23. What is the weight of 25 firkins of butter, each containing 56 pounds ?
24. At \$1.75 per yard, how many yards of cloth can be bought for \$49 ?
25. If the interest of \$1 is 6¢ a year, what is the interest of three dollars for two years ?
26. If 4 boxes of raisins cost \$7, what will 12 boxes cost ?
27. A man having 75 dollars bought 7 sheep, and had \$5 left. What did he pay for each sheep ?
28. A boy had 59 peaches and found 22 more; he then divided all of them equally among 9 boys. How many did he give to each ?

29. I bought $2\frac{1}{2}$ pounds of sugar at one store and $3\frac{1}{4}$ pounds at another. How many pounds did I buy in all?

30. If $\frac{1}{6}$ of a load of hay is worth \$14, what will two loads be worth?

31. $2\frac{3}{4} + 1\frac{1}{2} = ?$

32. $2\frac{3}{4} \times 1\frac{1}{2} = ?$

33. $\frac{3}{4}$ of my money equals 63¢. What is $\frac{1}{2}$ of it?

34. Least common multiple of 8, 12, 15, 24?

35. If 5 men can do a piece of work in 12 days, in how many days can 3 men do twice as much work?

36. John lost $\frac{1}{4}$ of his money and has 96¢ left. How much had he at first?

37. At 6¢ a quart, what will 10 quarts 1 pint of milk cost?

38. I bought a dozen oranges at the rate of 4 oranges for 3¢, and sold them at the rate of 3 oranges for 4¢. How much did I make?

39. How long would it take 3 men to cut 12 cords of wood, if 4 men can cut 8 cords in 2 days?

40. John sold 24 tops at the rate of 3 tops for ten cents, and with the money bought pictures at 8¢ each. How many pictures did he buy?

41. How many pounds of cheese at $\frac{1}{2}$ of a dollar per pound can be bought for $\frac{3}{4}$ of a dollar?

42. 18 is $\frac{3}{4}$ of $\frac{7}{6}$ of what number?

43. If one man can do a piece of work in $11\frac{1}{4}$ days, in what time can 12 men do it?

44. How many times is $\frac{1}{3}$ contained in $2\frac{1}{2}$?

45. If oranges are 37½ cents per dozen, what will be the cost of a box containing 480 oranges?

248. Written Review Problems.

1. At 70 cents per 100 pounds, what will be the amount of duty on an invoice of 3622 steel rails, each rail being 27 feet long and weighing 60 pounds to the yard?
2. A man had property valued at \$6500. What will be his taxes at the rate of \$10.80 per \$1000?
3. Multiply seventy thousand fourteen hundred-thousandths by one hundred nine millionths, and divide the product by five hundred forty-five.
4. What number multiplied by $43\frac{1}{4}$ will produce $265\frac{5}{8}$?
5. What decimal of a bushel is 3 quarts?
6. A man sells $\frac{1}{2}$ of an acre of land for \$93.75. What would be the value of his farm of $150\frac{1}{4}$ acres at the same rate?
7. A coal dealer buys 375 tons coal at \$4.25 per ton of 2240 pounds. He sells it at \$4.50 per ton of 2000 pounds. What is his profit?
8. Bought 60 yards of cloth at the rate of 2 yards for \$5, and 80 yards more at the rate of 4 yards for \$9. I immediately sold the whole of it at the rate of 5 yards for \$12. How much did I gain?
9. A man purchased 40 bushels of apples at \$1.50 per bushel. Twenty-five hundredths of them were damaged, and he sold them at 20 cents per peck. He sold the remainder at 50 cents per peck. How much did he gain or lose?
10. If oranges are $37\frac{1}{2}$ cents per dozen, how many boxes, each containing 480, can be bought for \$60?
11. A man can do a piece of work in $18\frac{1}{4}$ days. What part of it can he do in $6\frac{1}{2}$ days?
12. How old to-day is a boy that was born Oct. 29, 1896?

13. At the rate of \$5 per ton, what should be paid for 125 pounds of coal?

14. From ten and five hundredths take the sum of six ten-thousandths and 15 millionths, multiply the remainder by one-tenth, and divide the product by 5000.

15. Reduce the following common fractions to decimals, and perform the operations indicated:

$$\left(\frac{41}{5000} \times 7\frac{1}{20}\right) + \frac{141}{200000}$$

16. A man died in 1903, aged 94; his son died in 1887, aged 47. How old was the man at the birth of his son?

17. Multiply the sum of $6\frac{3}{4}$ and $4\frac{1}{4}$ by their difference.

18. What will be the cost of 86,400 feet of gas at \$1.25 per thousand feet?

19. What time elapsed between the discovery of America, Oct. 14, 1492, and Jan. 1, 1904?

20. How many hats can be bought for \$237.25, at the rate of \$13 per dozen?

21. A clerk receives a salary of \$1500 per year, and his expenses are \$968. In what time can he save enough to buy 133 acres of land at \$28 per acre?

22. What will be the rent of a house for 1 yr. 10 mo. at \$45 per month?

23. The product is .00087, the multiplicand is 7.25. What is the multiplier?

24. A man sells cloth at \$2.88 per yard, losing .04 of the cost. How much did he pay per yard?

25. A farm hand agreed to work for \$300 per year and a horse worth \$60. If he leaves at the end of 9 months, how much is due him if he has already received \$100 and the horse?

26. A train running 36 miles per hour leaves a station at 9 A.M. At 10.30 A.M. a second train leaves and runs at the rate of 30 miles per hour. How many miles apart are the trains at noon, if they run in the same direction?
27. Multiply twenty thousand nine hundred eight by sixteen. Divide the result by seven.
28. Divide two hundred sixteen by thirty-six thousandths. Take seventy-five hundredths from the quotient.
29. If one acre yields 14 bu. 3 pk. cranberries, how much will 40 acres yield?
30. Find the difference between $3\frac{1}{5} \times 6\frac{2}{5}$ and $7\frac{1}{5} \div 1\frac{3}{5}$.
31. An errand boy receives \$2.75 per week. In how many weeks will he earn enough to buy a pair of boots worth \$3.25, a coat worth \$4.75, a hat worth \$1.50, and 6 handkerchiefs worth 25 cents each?
32. How many cords of wood at $\$5\frac{1}{4}$ a cord must I give for $78\frac{1}{2}$ bushels of wheat at \$1.20 a bushel, and 84 bushels of rye at \$1 a bushel?
33. Mr. Louis Scott bought from Thomas Green, at Philadelphia, Jan. 10, 1904, the following: 67 pairs of boots at \$3.25 per pair; 75 pairs of gaiters at \$1.12 per pair; 35 pairs of slippers at 70 cents per pair; 50 pairs of rubbers at $62\frac{1}{2}$ cents per pair. Make out and receipt the bill.
34. What will $\frac{4}{5}$ of a yard of cloth cost, if $\frac{4}{5}$ of a yard costs \$1.60?
35. Divisor $3\frac{7}{8}$; quotient 400. Find dividend.
36. Dividend .014; quotient 2000. Find divisor.
37. Divide 118.35 by $.04\frac{1}{2}$, and add 3.0045 to the quotient.
38. If $1\frac{2}{3}$ yards of cloth are worth $11\frac{1}{4}$ dollars, what is a yard worth?

39. If a roll of carpet, containing 75 yards, is worth \$132, what is $\frac{2}{3}$ of a yard worth?
40. How many quarts of berries at 11 cents a quart will it take to buy $2\frac{1}{2}$ yards of cloth at $16\frac{1}{2}$ cents a yard?
41. A man sold $\frac{1}{2}$ and $\frac{1}{3}$ of his farm and had $26\frac{2}{3}$ acres left. How many acres had he at first?
42. A boy sleeps $\frac{2}{3}$ of his time, plays $\frac{1}{6}$ of it, and goes to school one-half the remainder. How many hours is he in school each school day?
43. Write in four other ways the quantity or value expressed by .16.
44. Bought 3 bu. 2 pk. of oats for \$1.38 and retailed them at $\$12\frac{1}{2}$ a peck. What was the gain?
45. From a hogshead of molasses containing 54 gal. 2 qt. there was sold 23 gal. 1 pt. What was the value of the remainder at 8 cents a quart?
46. What is the result, if the sum of 5 yd. 2 ft., 3 yd. 1 ft., and 14 yd. 1 ft. be taken from 42 yards?
47. Reduce $\frac{1}{8}$ of a day, $\frac{3}{10}$ of an hour, and $\frac{4}{15}$ of a minute to common denominator, and add.
48. Bought a carriage for \$180, and after paying 10% for repairs, sold it at a profit of 25% of the total cost. Find gain and selling price.
49. A man sold a horse for \$125, and received in payment $12\frac{1}{2}$ yards of cloth at \$3.25 a yard, and the balance in tea at \$.62 $\frac{1}{2}$. How many pounds of tea did he receive?
50. Find equivalent per cents for the following: $\frac{1}{5}$, $\frac{2}{3}$, $\frac{7}{8}$, $\frac{2}{5}$, $\frac{1}{2}$, $\frac{3}{4}$.
51. If 64 tons of iron cost \$4816, how many tons can be bought for \$1730.75?
52. Change 28 gal. 3 qt. to quarts.

53. A man carried to a store $75\frac{1}{4}$ bushels of potatoes, and received for them $27\frac{1}{4}$ ¢ a bushel. How many yards of cloth, at $17\frac{1}{4}$ ¢ a yard, would have paid for them?

54. What will 75 men earn in $18\frac{3}{4}$ days, if each earns $2\frac{1}{4}$ dollars each day?

55. What will 8 yd. 2 ft. 6 in. of silver wire cost at $8\frac{1}{4}$ ¢ an inch?

56. A young man spent \$195 $\frac{1}{4}$ during his first term at college, which was $\frac{1}{4}$ of his year's allowance. What was his year's allowance, and what had he left for the remainder of the year?

57. A man paid \$18.60 for a load of hay weighing $2\frac{1}{2}$ tons. At the same rate, what should he pay for $\frac{3}{4}$ of a ton?

58. Divide 4.5006 by .015.

59. One man owns $\frac{75}{800}$ of an estate; another owns $\frac{225}{800}$ of it; and a third man owns $\frac{38}{216}$ of it. What part of the whole do they own together?

NOTE.—Reduce the fractions to lowest terms, by inspection.

60. If it takes 11 men $45\frac{1}{4}$ days to do a piece of work, how many days will it take one man to do the same work?

61. I owned $\frac{2}{3}$ of a house, and sold $\frac{1}{4}$ of my share for \$1750. What was the value of the whole house at that rate?

62. A grocer, after selling $\frac{1}{8}$, $\frac{2}{5}$, $\frac{3}{20}$, and $\frac{1}{4}$ of a quantity of sugar, had 102 pounds left. How many pounds did he have at first?

63. A dealer in grain bought wheat at 94¢ a bushel to the amount of \$59.22, and sold it for \$70.56. What was the selling price per bushel?

64. If $\frac{5}{6}$ of a cord of wood is worth \$3.75, what will $\frac{1}{4}$ of a cord cost?

65. A man who had \$50 $\frac{1}{2}$, received \$8 $\frac{1}{4}$ more, spent \$17 $\frac{1}{4}$, lost \$4 $\frac{3}{5}$, and collected \$15 $\frac{1}{2}$ of a debt. How much money had he then?

66. 12 $\frac{3}{4}$ is what part of 29?

67. What must a carpenter pay for the following: 6500 shingles, at \$4.75 per thousand; 15,964 feet of boards, at \$39.25 per thousand; 4849 feet of planks, at \$45.32 per thousand?

68. A farmer sold $\frac{4}{5}$ of his wheat for \$796 $\frac{3}{4}$ and received for it \$1\frac{1}{10} per bushel. How many bushels did he have at first, and how many did he sell?

69. If 123 tons of coal cost \$848.70, what will be the cost of 265 tons?

70. A dealer sold $\frac{1}{2}$ of his wheat to Mr. Adams, $\frac{1}{3}$ of it to Mr. Baker, and $\frac{1}{8}$ of it to Mr. Charles; then he had 630 bushels left. How much had he at first?

71. Mr. Blank bottled 135 gallons of ink in bottles that held $\frac{2}{3}$ of a pint; he sold it for 12 $\frac{1}{2}$ ¢ a bottle. How much did he receive?

72. Three times a number, increased by $\frac{6}{10}$ of the number, equals 22. What is the number?

73. A grocer having a capital of \$10,000, invested $\frac{1}{5}$ of it in tea at $\frac{7}{20}$ of a dollar per pound, $\frac{5}{20}$ of the remainder in coffee at $\frac{1}{4}$ of a dollar a pound, and $\frac{8}{25}$ of the rest in sugar at 5 cents per pound. What quantity of each did he buy, and what money had he left?

74. What will be the cost of 53,715 pounds of wheat at 90 cents per bushel of 60 pounds?

75. A drover sold 15 cattle, weighing 1468 pounds each, at \$4.40 per hundred pounds. How much did he receive?

76. After losing $\frac{2}{5}$ of his money, a man had \$75 left. How much had he at first?

77. What will be the cost of 24 gallons 3 quarts of milk at 4 cents per pint?

78. A man bought a house for \$6250 and sold it for \$6500. What fraction of the cost is the profit? What decimal?

79. At \$30 per month, how much rent would a man pay from July 1, 1904, to May 1, 1906?

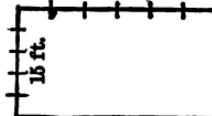
80. How many sheep at \$6.75 each should be given in exchange for 54 horses worth \$160 each?

81. A man spent three-tenths of his money for clothes, and one-fifth of it for rent, and had \$75 left. How much did his clothes cost?

82. What would be the cost of 48,500 stamped envelopes at \$21.30 per thousand?

83. The width of a room is $\frac{2}{3}$ of its length. How many square feet in the floor, if the width is 15 feet?

84. If 2 lb. 6 oz. of tea cost 95 cents, how many pounds and ounces can be bought for \$2.35?



85. John and James went out together. John had 38 cents. When one of the boys had spent 18 cents and the other had spent 16 cents, they had 24 cents left between them. Find the amount of money James had.

86. Find $\frac{1}{2}$ of the sum of $\frac{2}{3}$ and $\frac{3}{4}$.

87. What is $\frac{2}{3}$ of the difference between $\frac{4}{5}$ and $\frac{5}{6}$?

88. What fraction added to $\frac{2}{7}$ gives $\frac{3}{4}$?

89. Change $1\frac{3}{11}$ hour to seconds.

90. $\frac{6}{7}$ of what number equals 180?

91. The half of a number added to its fourth part equals $21\frac{1}{4}$. What is the number?



92. A farm is sold for \$5700, at a loss of $\frac{1}{20}$ of the cost. What was the cost?

93. When it is noon at Philadelphia, it is 15 seconds and 10 minutes past 5 P.M. at Paris. What time is it at Philadelphia when it is noon at Paris?

94. A, B, and C buy a house. A furnished $\frac{1}{2}$ of the cost, B $\frac{1}{3}$, and C \$1200. What did A and B pay, respectively?

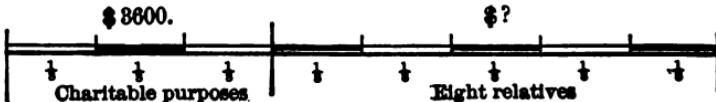


95. After James has spent $\frac{1}{4}$ of his money and $\frac{1}{2}$ of the remainder, he has but \$1.50 left. How much had he at first?

96. A man buys oranges at \$1.20 per 100. How many would he have to sell, at 25¢ per dozen, to gain \$3.18?

97. From a piece of cloth measuring $28\frac{1}{2}$ yards, there have been sold $2\frac{2}{3}$ yards, $6\frac{1}{2}$ yards, $13\frac{3}{4}$ yards. If the remainder is worth \$13.10, what was the value of the whole piece?

98. A man left for charitable purposes \$3600, which was $\frac{1}{4}$ of his money. The remainder was divided equally among 8 relatives. How much did each relative receive?



CHAPTER IV.

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DENOMINATE NUMBERS.

249. Preliminary Exercises.

- How many quarts in 5 gal. ?
- How many quarts in 5 gal. 3 qt. ?
- How many pints in 23 qt. ?
- How many pints in 23 qt. 1 pt. ?
- How many pints in 5 gal. 3 qt. 1 pt. ?

REDUCTION DESCENDING.

250. Reduce 5 gal. 3 qt. 1 pt. to pints.

In the first few examples, write 4 (the number of quarts in a gallon) above the quarts, and 2 (the number of pints in a quart) above the

pints. In 5 gallons there are 5 times 4 quarts, or 20 quarts ; adding the 3 quarts, we have 23 quarts, as the equivalent of 5 gallons 3 quarts, which is written in the column of quarts. In 23 quarts there are 23 times 2 pints ; adding 1 pint, we have 47 pints as the equivalent of 5 gallons 3 quarts 1 pint. This is written in the column of pints, the 23 quarts being cancelled.

$$\begin{array}{r}
 & 4 \text{ qt.} & 2 \text{ pt.} \\
 5 \text{ gal.} & 3 \text{ qt.} & 1 \text{ pt.} \\
 \hline
 & 23 \text{ qt.} & 47 \text{ pt.}
 \end{array}$$

Ans. 47 pt.

Changing a denominate number to an equivalent denominate number of a lower denomination is called *reduction descending*.

251. Written Exercises.

Reduce to pints :

- | | |
|------------------------|-------------------------|
| 1. 16 gal. 1 qt. 1 pt. | 6. 31½ gal. |
| 2. 27 gal. 2 qt. | 7. 9 gal. 2½ qt. |
| 3. 16 gal. | 8. 10 gal. 2 qt. 1 pt. |
| 4. 16 gal. 1 pt. | 9. 27 gal. 1 pt. |
| 5. 34 gal. 3 qt. 1 pt. | 10. 4 gal. 3 qt. 1½ pt. |

REDUCTION ASCENDING.

252. Change 67 pt. to gallons, quarts, and pints.

Place 2 (the number of pints in a quart) above 67 pints. In 67 pints there are 33 quarts and 1 pint. Write 33 quarts to the left of 67 pints, and the 1 pint remainder in the column of pints. Change the 33 quarts to 8 gallons 1 quart, and cancel 33 quarts.

$$\begin{array}{r}
 & 4 \text{ qt.} & 2 \text{ pt.} \\
 33 \text{ qt.} & 67 \text{ pt.} \\
 \hline
 8 \text{ gal.} & 1 \text{ qt.} & 1 \text{ pt.}
 \end{array}$$

Ans.

Changing a denominate number to an equivalent denominate number of a higher denomination is called *reduction ascending*.

253. Written Exercises.

Change to gallons, etc.

- | | |
|-------------|-------------|
| 1. 156 qt. | 6. 177 pt. |
| 2. 79 qt. | 7. 139 pt. |
| 3. 408 pt. | 8. 171 qt. |
| 4. 1302 pt. | 9. 63 qt. |
| 5. 63 pt. | 10. 711 pt. |

254. Review the tables of Long Measure, Dry Measure, Liquid Measure, Avoirdupois Weight, and Time, Art. 93, pages 43-44.

Change:

1. 17 yd. 1 ft. 9 in. to inches.
2. 4 mi. 100 rd. 4 yd. to yards.
3. 74 bu. 2 pk. 7 qt. to quarts.
4. 156 lb. 11 oz. to ounces.
5. 63 yd. 0 ft. 3 in. to inches.
6. 19 bu. 0 pk. 3 qt. to quarts.
7. 11 rd. $3\frac{1}{2}$ yd. to feet.
8. 63 gal. 3 qt. to pints.
9. 3 bu. 6 qt. to quarts.
10. 17 T. 369 lb. to pounds.
11. 15 hr. 16 min. to seconds.
12. 4 wk. 6 da. 11 hr. to hours.

NOTE. — Reduce a denominate fraction or a denominate decimal to lower denominations by multiplying.

13. $\frac{4}{7}$ of a week to hours.
14. $\frac{8}{3}$ of a mile to yards.
15. .00125 ton to ounces.
16. 1876 inches to yards, etc.
17. 475 ounces to pounds, etc.

18. 729 quarts to bushels, etc.
19. 8675 minutes to days, etc.
20. 4972 pounds to tons, etc.
21. 972 rods to miles, etc.
22. 117 pints to gallons, etc.
23. 9483 seconds to hours, etc.
24. 877 quarts to bushels, etc.
25. 1495 ounces to pounds, etc.
26. 373 inches to yards, etc.
27. 216 quarts to gallons, etc.
28. 876 rods to miles, etc.
29. 319 pints to gallons, etc.
30. 3520 yards to miles.

255. Oral Exercises.

1. How many hours in $\frac{2}{3}$ of a day ?
2. How many hours in $\frac{1}{3}$ of a day ?
3. How many minutes in $\frac{4}{5}$ of an hour ?
4. How many hours and minutes in $\frac{1}{2}$ of a day ?

$\frac{1}{2}$ day = $4\frac{1}{2}$ hours ; $\frac{1}{3}$ hour = 48 minutes. $\frac{1}{5}$ day = 4 hours 48 minutes.

5. How many quarts and pints in $\frac{3}{8}$ of a gallon ?
6. How many hours and minutes in .2 day ?

.2 day = 4.8 hours ; .8 hour = 48 minutes. .2 day = 4 hours 48 minutes.

7. How many quarts and pints in .375 gallon ?
8. Change .3 day to hours and minutes.
9. Change .625 bushel to pecks and quarts.
10. What part of a gallon is 1 pint ?
11. What part of a gallon is 3 pints ?

12. What part of a gallon is 1 qt. 1 pt.?
13. What decimal of a gallon is 1 qt. 1 pt.?
14. What decimal of a gallon is 2 qt. 1 pt.?
15. What part of 2 gallons is 2 qt. 1 pt.?
16. Change .375 bushel to pecks and quarts.
17. What decimal of a bushel is 4 quarts?
18. What fraction of a day is 3 hr. 20 min.?
19. Reduce 960 minutes to hours.
20. How many minutes in a day?

256. Written Exercises.

1. What decimal of a ton is 3 pounds?

Pounds are changed to tons by dividing by 2000.

$$3 \text{ lb.} = \frac{3}{2000} \text{ T.} = .0015 \text{ T.} \quad \text{Ans.}$$

2. What fraction of an hour is 12 min. 30 sec.?

$$12 \text{ min. } 30 \text{ sec.} = 12\frac{1}{2} \text{ min.} = \frac{12\frac{1}{2}}{60} \text{ hr.} = \frac{25}{120} \text{ hr.} = \frac{5}{24} \text{ hr.}$$

3. Reduce $\frac{1}{3}\frac{1}{2}$ of a day to minutes.

$$\frac{1}{3}\frac{1}{2} \text{ day} = (\frac{1}{3} \times 24) \text{ hr.} = (\frac{1}{3} \times 24 \times \frac{60}{1}) \text{ min.} \quad \text{Cancel.}$$

4. Reduce .03125 day to minutes.

5. What decimal of a day is 9 minutes?

6. What will be the cost of 15 T. 500 lb. coal at \$7 per ton?

7. When coal is \$5 per ton, how many tons and pounds can be bought for \$18.75?

8. Change 2 ft. 7 in. to the fraction of a yard.

$$2 \text{ ft. } 7 \text{ in.} = 2\frac{7}{12} \text{ ft.} = \frac{2\frac{7}{12}}{3} \text{ yd.} = \frac{11}{12} \text{ yd.}, \quad \text{Ans.}$$

NOTE. — An expression such as $\frac{2\frac{7}{12}}{3}$ is called a *complex fraction*. It indicates the division of $2\frac{7}{12}$ by 3; that is, $\frac{11}{12} \times \frac{1}{3}$, or $\frac{11}{36}$.

9. Reduce 3 pk. 4 qt. to the decimal of a bushel.

$$4 \text{ qt.} = .5 \text{ pk.}; 3 \text{ pk. } 4 \text{ qt.} = 3.5 \text{ pk.} = \frac{3.5}{4} \text{ bu. ; etc.}$$

10. How many pecks and quarts in .9375 bushel?

11. If .1875 of a gallon of cologne cost \$ 1.125, what will 1 pint cost?

NOTE.—\$.125 is read 12 cents 5 mills.

12. Find the cost of 42 gal. 3 qt. 1 pt. oil, at 16 cents per gallon.

13. Reduce $\frac{1}{8}$ of a gallon to quarts and pints.

14. What part of 3 T. is 1 T. 960 lb.?

15. A man raised 194 bu. 1 pk. of rye. He sold 129 bu. 2 pk. What fraction of his crop did he sell?

16. 10 bu. 1 pk. of seed are packed in 8 bags. What quantity is there in each bag?

17. What decimal of a day is 15 hr. 45 min.?

18. How many feet are there in a mile?

COMPOUND ADDITION.

A compound denominate number expresses two or more denominations of the same kind.

316 T. 1816 lb. is a compound denominate number.

487 T. is a simple denominate number.

In adding and subtracting compound denominate numbers, write units of the same denomination in the same column.

257. Add the following:

1.	18 bu. 3 pk. 7 qt.	7 qt. + 4 qt. + 6 qt. = 17 qt. = 2 pk. 1 qt.
	9 bu. 2 pk. 4 qt.	Write 1 qt. and carry 2 pk. 2 pk. + 2 pk.
	14 bu. 1 pk. 6 qt.	+ 1 pk. + 2 pk. + 3 pk. = 10 pk. = 2 bu. 2 pk.
	2 pk.	Write 2 pk. and carry 2 bu. 2 bu. + 14 bu.
		+ 9 bu. + 18 bu. = 43 bu.

Ans. 43 bu. 2 pk. 1 qt.

- | | |
|--|---|
| 2. 16 yd. 2 ft. 9 in.
17 yd. 4 in.
1 ft. 6 in.
<hr/> | 6. 12 T. 1576 lb.
3 T. 980 lb.
476 lb.
<hr/> |
| 3. 11 da. 5 hr. 19 min.
23 da. 40 min.
17 hr. 50 min.
<hr/> | 7. 2 wk. 5 da. 12 hr.
6 da. 15 hr.
5 wk. 2 hr.
<hr/> |
| 4. 93 gal. 3 qt. 1 pt.
74 gal.
18 gal. 1 qt.
<hr/> | 8. 18 mi. 100 rd.
34 rd.
29 mi.
<hr/> |
| 5. 5 hr. 30 min. 20 sec.
45 min. 33 sec.
6 hr. 11 min. 5 sec.
<hr/> | 9. 47 yr. 11 mo.
5 yr. 9 mo.
7 mo.
<hr/> |
| 10. 487 T., 316 T. 1816 lb., 247 lb., 43 T. 811 lb., 19 T. 25 lb.
11. 83 lb. 15 oz., 9 lb. 5 oz., 18 lb., 22 lb. 11 oz., 5 lb. 8 oz.
12. 8 hr. 15 min. 5 sec., 37 min. 52 sec., 5 hr. 48 min., 23 hr.
13. 72 gal. 3 qt. 1 pt., 17 gal. 1 qt., 2 qt. 1 pt., 90 gal. 1 pt.
14. 7 yd. 2 ft. 11 in., 19 yd. 6 in., 105 yd. 4 yd. 2 ft. 2 in., 1 ft.
15. 93 mi. 300 rd., 87 mi. 154 rd., 194 rd., 3 mi. 175 rd., 9 mi. | |

COMPOUND SUBTRACTION.

258. Subtract:

- Change 83 yr. 3 mo. to 82 yr. 15 mo. Subtract 9 months from 15 months. Write the remainder, 6 months, in the column of months. Subtract 15 years from 82 years.
1. 83 yr. 3 mo. 15 yr. 9 mo.

Ans. 67 yr. 6 mo.

Chapter Four.

- | | |
|---|---|
| 2. 62 mi. 84 rd.
19 mi. 159 rd. | 7. 18 hr. 5 min.
40 min. 25 sec. |
| <hr/> | <hr/> |
| 3. 76 T. 225 lb.
37 T. 1679 lb. | 8. 16 yd. 9 in.
7 yd. 1 ft. 11 in. |
| <hr/> | <hr/> |
| 4. 100 lb.
83 lb. 4 oz. | 9. 100 bu.
42 bu. 3 pk. 7 qt. |
| <hr/> | <hr/> |
| 5. 52 wk.
13 wk. 3 da. 7 hr. | 10. 45 da. 1 hr. 1 min.
6 da. 6 hr. 6 min. |
| <hr/> | <hr/> |
| 6. 19 gal. 1 pt.
8 gal. 3 qt. | |
| <hr/> | |
| 11. From 27 bu. 1 pk. 5 qt. take 13 bu. 3 pk. 7 qt. | |
| 12. From 100 gal. 1 qt. take 83 gal. 2 qt. 1 pt. | |
| 13. From 22 hr. 15 min. 20 sec. take 15 hr. 45 min. 40 sec. | |
| 14. From 17 lb. 2 oz. take 13 lb. 8 oz. | |
| 15. From 100 bu. take 74 bu. 2 pk. 1 qt. | |

COMPOUND MULTIPLICATION.

259. Written Exercises.

Multiply 4 gal. 3 qt. 1 pt. by 3.

$$\begin{array}{r}
 4 \text{ gal. } 3 \text{ qt. } 1 \text{ pt.} \\
 \times \quad \quad \quad \quad \quad 3 \\
 \hline
 12 \text{ gal. } 9 \text{ qt. } 3 \text{ pt. } \textit{Ans.}
 \end{array}$$

3 times 1 pt. = 3 pt. 3 pt = 1 qt.
 1 pt. Write 1 pint in the column of
 pints. 3 times 3 qt. = 9 qt.; 9 qt. +
 the 1 qt. to carry = 10 qt. 10 qt. =
 2 gal. 2 qt. Write 2 quarts in the
 column of quarts. 3 times 4 gal. =
 12 gal.; 12 gal. + 2 gal. to carry = 14 gal. *Ans.* 14 gal. 2 qt. 1 pt.

Multiply:

- | | |
|-----------------------------------|----------------------------------|
| 1. 13 bu. 3 pk. 6 qt. by 2. | 7. 25 lb. 4 oz. by 8. |
| 2. 25 gal. 2 qt. 1 pt. by 3. | 8. 33 min. 33 sec. by 9. |
| 3. 7 lb. 10 oz. by 4. | 9. 2 pk. 7 qt. by 10. |
| 4. 23 bu. 3 qt. by 6. | 10. 3 qt. 1 pt. by 11. |
| 5. 32 gal. 1 pt. by 7. | 11. 4 yr. 6 mo. by 12. |
| 6. 3 hr. 15 min. 15 sec.
by 5. | 12. 5 wk. 6 da. 12 hr.
by 16. |

COMPOUND DIVISION.

260. Divide 54 yd. 1 ft. 4 in. by 20.

20) 54 yd. 1 ft. 4 in. 54 yd. + 20 gives a quotient of 2 yd.,
 2 yd. 2 ft. 2 in. *Ans.* which is written, and a remainder of
 14 yd. Reduce 14 yd. to 42 ft., and
 add 1 ft., making 43 ft. 43 ft. + 20 gives a quotient of 2 ft., which is
 written, and a remainder of 3 ft. Reduce 3 ft. to 36 in., and add 4 in.,
 making 40 in. 40 in. + 20 gives a quotient of 2 in. which is written.

Divide:

- | | |
|-----------------------|----------------------------------|
| 1. 13 wk. by 5. | 7. 17 lb. 7 oz. by 3. |
| 2. 15 lb. 9 oz. by 3. | 8. 37 bu. 3 pk. 6 qt. by 2. |
| 3. 2 lb. 3 oz. by 5. | 9. 67 yd. 2 ft. by 4. |
| 4. 2 gal. 1 qt. by 3. | 10. 33 da. 15 hr. 57 min. by 3. |
| 5. 5 bu. by 4. | 11. 561 gal. by 6. |
| 6. 7 hr. by 6. | 12. 22 hr. 20 min. 20 sec. by 4. |
| | 13. 109 gal. 1 qt. 1 pt. by 7. |
| | 14. 273 yd. 1 ft. 6 in. by 9. |
| | 15. 155 bu. 3 pk. 2 qt. by 6. |
| | 16. 180 da. 19 hr. 28 min. by 8. |

17. Divide 243 da. 4 hr. 2 min. by 15.

Dividing 243 days

by 15 gives a quotient
of 16 days and a re-
mainder of 3 days. Re-
ducing 3 days 4 hours
to 76 hours and divid-
ing by 15 gives a quo-
tient of 5 hours and a
remainder of 1 hour.

Reducing 1 hour 2 minutes to 62
minutes and dividing by 15 gives
a quotient of 4 minutes and a
remainder of 2 minutes. Reducing 2 min-
utes to 120 seconds and dividing by 15 gives
a quotient of 8 seconds.

$$\begin{array}{r}
 & 16 \text{ da.} & 5 \text{ hr.} & 4 \text{ min.} & 8 \text{ sec.} \\
 15) & 243 \text{ da.} & 4 \text{ hr.} & 2 \text{ min.} & \\
 & \underline{15} & & & \\
 & 93 \text{ da.} & & & \\
 & \underline{90} & & & \\
 & 3 \text{ da.} & 4 \text{ hr.} & & \\
 & \underline{\underline{76}} & & & \\
 & 75 \text{ hr.} & & & \\
 & \underline{\underline{1}} & \text{hr.} & 2 \text{ min.} & \\
 & & & 62 \text{ min.} & \\
 & & & 60 \text{ min.} & \\
 & & & \underline{\underline{2}} & \\
 & & & & 120 \text{ sec.} \\
 & & & & \underline{\underline{120}} \text{ sec.}
 \end{array}$$

18. Divide 334 yd. 9 in. by 21.

$$\begin{array}{r}
 15 \text{ yd.} & 2 \text{ ft.} & 9 \text{ in.} \\
 \hline
 21) & 334 \text{ yd.} & 0 \text{ ft.} & 9 \text{ in.}
 \end{array}$$

$$\begin{array}{r}
 21 \\
 \underline{124} \text{ yd.} \\
 105 \text{ yd.} \\
 \underline{\underline{19}} \text{ yd.} \\
 57 \text{ ft.} \\
 42 \text{ ft.} \\
 \hline
 15 \text{ ft.} & 9 \text{ in.} \\
 \hline
 189 \text{ in.} \\
 \hline
 189 \text{ in.}
 \end{array}$$

Insert the missing denomina-
tion, feet, with a cipher prefixed.
Reduce the 19 yards remainder to
57 feet. Reduce to 189 inches the
15 feet 9 inches remaining.

19. 825 lb. by 48.

20. 112 T. by 25.

21. 43 mi. by 32.

22. 84 yr. by 24.

23. 462 bu. by 32.

24. 1078 yd. by 63.

25. 288 hr. 9 min. by 54.

26. 863 gal. 2 qt. 1 pt. by 47.

27. 33 wk. 1 da. by 72.

28. 1138 T. 910 lb. by 81.

29. 1629 yd. 1 ft. by 96.

30. 1867 gal. $1\frac{1}{2}$ pt. by 125.

261. Avoirdupois Weight. Long Ton.

In selling iron, coal at the mines, ores, etc., and in calculating the duties at the U. S. custom houses upon imported goods, the following table is used :

28 pounds (lb.)	= 1 quarter (qr.)
4 quarters	= 1 hundredweight (cwt.)
20 hundredweight	= 1 ton (T.)

$$1 \text{ cwt.} = 112 \text{ lb.} \quad 1 \text{ T.} = 2240 \text{ lb.}$$

The ton of 2240 pounds is called a *long ton*. Unless otherwise specified in a problem, the cwt. of 100 pounds and the ton of 2000 pounds are to be taken.

262. Oral Problems.

1. How many tons and pounds of coal in 40 bags, each containing 80 pounds ?
2. If it takes 3 hr. 20 min. to hoe a row of corn, how long will it take to hoe 3 rows ?
3. A man puts up $3\frac{1}{2}$ pounds of tea into 4 ounce packages. How many packages does he make ?
4. 3 pk. 3 qt. of apples are divided among 9 children. What quantity does each child receive ?
5. What part of a day is 30 minutes ?
6. If there are $2\frac{1}{4}$ gallons of wine in 12 bottles, how many pints are there in each bottle ?
7. What is the weight of two packages each containing 15 lb. 11 oz. ?
8. What part of an hour is 40 seconds ?
9. What is the rent of a house for 1 year 9 months at \$16 per month ?
10. If 3 gal. 2 qt. 1 pt. of milk are taken from a can containing 10 gallons, how much is left in the can ?

11. 5 hams weigh $61\frac{1}{4}$ pounds. What is the average weight?

12. There are on an average 41 pupils in a class. How many are there in 14 classes?

13. At $37\frac{1}{2}$ cents per yard, how many yards can be bought for \$6.75?

$$\$6\frac{3}{4} + \$\frac{3}{4} = \frac{15}{4} + \frac{3}{4} = \frac{18}{4} + \frac{3}{4}, \text{ etc.}$$

14. Find the cost of 16 barrels of flour at $\$6.12\frac{1}{2}$ each.

15. \$1.65 is equally divided among 15 boys. What is the share of each?

16. A floor containing $40\frac{1}{4}$ square yards is 7 yards long. How many yards wide is it?

17. How many ounces in $5\frac{1}{2}$ pounds?

263. Written Problems.

1. If a watch gains 1 min. 17 sec. per day, how much will it gain during March and April?

2. How many bushels, pecks, and quarts in 1449 pounds of corn, weighing 56 pounds to the bushel?

3. Reduce 25 T. 13 cwt. 2 qr. 25 lb. to pounds (long ton).

4. A chain, 97 yd. 8 in. long, contains 1000 links. Find the length of one of the links.

5. A farmer sold out of 5 bushels of peas the following quantities: 3 pk. 6 qt.; 4 pk.; 4 pk. 3 qt.; 1 bu. 1 pk. 1 qt. How much has he still to sell?

6. Change 100,000 pounds to tons (long), cwt., qr., lb.

7. A man walks on Monday 15 mi. 161 rd.; Tuesday, 10 mi. 84 rd.; Wednesday, 19 mi. 15 rd.; Thursday and Friday, 12 mi. 121 rd. each day; Saturday, 14 mi. 240 rd. What distance per day does he average?

8. If the sun rises at 5 hr. 10 min. A.M., and sets at 6 hr. 42 min. P.M., how long is the day? How many hours and minutes of night?
9. Find the duty at $1\frac{1}{10}\%$ per pound on an invoice of tin weighing 33 T. 7 cwt. 20 lb. (long ton).
10. An iron rod is 12 ft. 6 in. long. From it are cut 73 bolts, each $1\frac{1}{4}$ inches long. How much is left?
11. A man rows a mile in 10 min. 30 sec. How long would he take to row 27 miles at the same rate?
12. What is the total weight in tons (long), etc., of 19 barrels of soda-ash weighing 13 cwt. 2 qr. 10 lb. each?
13. A man rows 51 miles in 23 hr. 5 min. and 30 sec. How long does he take to row a mile?
14. If I lost \$50 by selling a lot for two-thirds of its cost, what would I have lost if I had sold it for three-fourths of its cost?
15. At the rate of \$2.75 per day of 8 hours, how much should be given a man that works from a quarter before 8 in the morning until 5 minutes past 11 in the morning?
16. If a railroad train travels 18 miles in 40 minutes, how far will it travel, at the same rate, in $7\frac{1}{2}$ hours?
17. A coal dealer buys 175 (long) tons of coal. How much does he receive for it at \$5 per ton of 2000 pounds?

TIME BETWEEN DATES.

264. Oral Problems.

1. How many hours from 3 o'clock Saturday afternoon to 9 o'clock Sunday morning?
2. How many days from May 1 to June 1?
3. A boy takes a spoonful of medicine every hour. If he takes the first dose at 2 o'clock, at what hour will he take the sixth? The second? The fourth?

4. A man begins work on the morning of the 6th and ends on the evening of the 11th. How much does he earn at \$3 per day?
5. An importer receives some cases of goods numbered consecutively. How many cases are there if the lowest number is 29 and the highest number is 53?
6. How many posts 6 feet apart will be needed for a fence 120 feet long. For a fence 6 feet long? 12 feet long?
7. Find the time from Jan. 1 to Jan. 31, counting the first and the last day. Omitting both days.
8. How many days from July 4 to Aug. 15, inclusive?
9. How many chapters from the 25th to the 49th, exclusive?
10. A girl begins at the 146th problem and solves all those on two pages. If the last is the 172d problem, how many does she solve?

265. How many days from March 4 to Sept. 1?

March 4 to March 31, 27 days

Excluding March 4, there remain in the month $31 - 4$, or 27 days. To this add the number of days in April, May, June, July, and August. Since March 4 is excluded, we take 1 day in September, making the total 181 days.

April	30
May	31
June	30
July	31
Aug.	31
Sept.	1

Ans. 181 days

In finding the time between dates, either the first or the last day is excluded; that is, from the 1st to the 21st is considered 20 days.

266. How many days from

- | | |
|---------------------------|-------------------------|
| 11. Jan. 1 to Feb. 19? | 16. Feb. 29 to April 1? |
| 12. Oct. 31 to Dec. 30? | 17. May 21 to July 4? |
| 13. Sept. 30 to Dec. 16? | 18. April 7 to May 27? |
| 14. Nov. 1 to Dec. 19? | 19. June 10 to Aug. 1? |
| 15. March 16 to April 25? | 20. July 4 to Sept. 1? |

267. Written Problems.

Take note of leap year.

How many days from :

1. Feb. 6, 1903, to Oct. 1, 1903?
 2. Oct. 14, 1903, to March 3, 1904?
 3. Jan. 1, 1904, to April 19, 1904?
 4. Dec. 23, 1904, to March 8, 1905?
 5. Sept. 3, 1903, to Feb. 1, 1904?
 6. March 16, 1904, to Dec. 25, 1904?
 7. June 3, 1905, to Nov. 29, 1905?
 8. Aug. 17, 1903, to Jan. 3, 1904?
 9. April 4, 1905, to July 4, 1905?
 10. May 16, 1906, to Oct. 14, 1906?
11. How much wages at \$4 per day should a man receive from Tuesday, Jan. 2, 1906, to Feb. 28, inclusive, no pay to be received for Sundays or legal holidays?
12. A man borrowed \$100 April 4, and returned it Nov. 25. How many days' interest did he owe? (Do not include both days.)
13. May 1, 1903, fell on Friday. Upon what day of the week did July 4 fall?

14. How many days does vacation last if it begins on the morning of Saturday, July 2, and school commences on the first Tuesday of September?

15. A man borrows some money June 16, and agrees to return it in 60 days. On what date should he pay it?

16. A traveller starts upon a trip Aug. 24, 1904, and reaches home again Feb. 10, 1905. How long is he away?

In each of the preceding examples the difference between the dates is less than a year, and the answer is required in days. When the difference is more than a year, it is generally obtained by compound subtraction, each month being considered as containing 30 days.

17. Find the difference in time between March 3, 1891, and Jan. 1, 1905.

Writing 1905, 1st month, 1st day, we subtract 1891, 3d month, 3d day.	$\begin{array}{r} 1905 & 1 & 1 \\ 1891 & 3 & 3 \\ \hline 13 & 9 & 28 \end{array}$
--	---

18. George Washington was born Feb. 22, 1732. How old was he at the signing of the Declaration of Independence, July 4, 1776?

19. Abraham Lincoln was first inaugurated president March 4, 1861. How long had he served at his death, April 15, 1865?

20. The battle of Lexington took place April 19, 1775. The treaty of peace was signed Sept. 3, 1783. How many years, months, and days between the two events?

21. How many years elapsed between the discovery of America by Columbus, Oct. 12, 1492, and the landing of the Pilgrims, Dec. 21, 1620?

22. General Harrison fought the battle of Tippecanoe Nov. 7, 1811. He was inaugurated president 29 yr. 3 mo. 27 da. later. Give the date of his inauguration.

23. How long was it after the treaty with England, signed Dec. 24, 1814, that the Mexican treaty was concluded, Feb. 2, 1848?

24. General Taylor died July 9, 1850. How long did he live after the capture of Monterey, Sept. 24, 1846?

25. President Garfield was born Nov. 19, 1831. How old was he at his inauguration, March 4, 1881?

26. The last battle of the Mexican War took place Sept. 14, 1847. The battle of Bull Run was fought 13 yr. 10 mo. 7 da. later. What was the date of this battle?

27. Find the time between July 4, 1776, and Jan. 1, 1904.

PERCENTAGE.

268. Oral Exercises.

- | | |
|----------------------|--------------------------------|
| 1. Find 4% of \$125. | 6. $33\frac{1}{3}\%$ of 1 day. |
| 2. 25% of 16. | 7. $62\frac{1}{2}\%$ of \$12. |
| 3. 6% of 200 cows. | 8. 9 % of \$23. |
| 4. 1% of 150 pounds. | 9. 75 % of 3 gallons. |
| 5. 20% of 65 yards. | 10. $1\frac{1}{4}\%$ of \$400. |

269. Written Exercises.

- | | |
|--|---|
| 1. Find 6% of \$576.
$\$576 \times .06$ | 9. 25 % of \$156.
$\frac{1}{4}$ of \$156 |
| 2. $4\frac{1}{2}\%$ of \$340. | 10. 1 % of \$156. |
| 3. 25 % of 1876 bushels. | 11. $\frac{1}{4}\%$ of \$156. |
| 4. $12\frac{1}{2}\%$ of 864 cows. | 12. 50 % of 480 hours. |
| 5. 50 % of 432 yards. | 13. $\frac{1}{2}\%$ of 480 hours. |
| 6. $33\frac{1}{3}\%$ of 576 soldiers. | 14. $\frac{1}{8}\%$ of \$1420. |
| 7. $16\frac{2}{3}\%$ of 696 gallons. | 15. $3\frac{1}{3}\%$ of \$66. |
| 8. $6\frac{1}{4}\%$ of \$4.96. | 16. $7\frac{1}{2}\%$ of 360 days. |

INTEREST.

270. *Interest* is the sum paid for the use of money.

The *Principal* is the sum loaned.

The *Amount* is the sum of the principal and interest.

In computing interest, the year is considered as composed of 12 months of 30 days each.

271. Oral Exercises.

Find the interest on:

1. \$90 for 2 months at 4%.
2. \$60 for 60 days at 6%.
3. \$100 for 2 yr. 6 mo. at 5%.
4. \$120 for 30 days at 5%.
5. \$300 for 90 days at 3%.
6. \$100 for 1 yr. 3 mo. at 4%.
7. \$50 for 3 years at 6%.
8. \$100 for 2 yr. 4 mo. at 6%.

272. Find the interest on \$63 for 4 yr. 5 mo. at 5%.

\$63.

Find the interest for one year by multiplying the principal, \$63, by the rate, 5, expressed as hundredths. Multiply this product, \$3.15, by the time expressed in years, $4\frac{5}{12}$.

$$\begin{array}{r}
 & .05 \\
 & \$ 3.15 \\
 & \times 4\frac{5}{12} \\
 \hline
 & \$ 15.75 \\
 & \$ 1.31 + \\
 & \hline
 & 12.60 \\
 \text{Ans. } & \hline
 & \$ 13.91
 \end{array}$$

\$63 is called the principal.

5 = rate. 4 yr. 5 mo. = time.

$$\text{Interest} = \text{Principal} \times \frac{\text{Rate}}{100} \times \text{Time (in years)}.$$

The work may sometimes be shortened by indicating the operations and cancelling:

$$\frac{\$.21}{\$63} \times \frac{5}{100} \times \frac{53}{12} = \frac{\$55.65}{4} = \$13.91 + .$$

Find the interest on \$160.50 for 3 mo. 15 da. at 6%.

$$\frac{\$1.605}{\$160.50} \times \frac{6}{100} \times \frac{7}{24} = \frac{\$11.235}{4} = \$2.808 + \quad \text{Ans. } \$2.81.$$

Note. — The divisor, 100, should be cancelled only in performing the final division.

Find the interest on \$69.75 for 1 mo. 17 da. at 4%.

$$\frac{\$.00775}{\$69.75} \times \frac{4}{100} \times \frac{47}{360} = \$.36425. \quad \text{Ans. } 36 \text{ cents.}$$

Note. — The three ciphers in the dividend are cancelled by moving the decimal point in the dividend three places to the left, prefixing a decimal cipher.

273. Written Exercises.

Find the interest on:

1. \$192 for 3 yr. 7 mo. at 5%.
2. \$60 for 2 mo. 12 da. at 4%.
3. \$240 for 1 yr. 1 mo. at 6%.
4. \$14.40 for 5 yr. 5 mo. at 5%.
5. \$36 for 77 days at $4\frac{1}{2}\%$.
6. \$99 for 21 months at 6%.
7. \$192 for 2 yr. 4 mo. at 5%.
8. \$600 from Jan. 1 to Jan. 16 at 4%.
9. \$1200 from July 1, 1903, to Jan. 1, 1905, at 6%.
10. \$57.60 from Oct. 4, 1904, to Feb. 4, 1908, at 5%.

274. Oral Problems.

1. 16 is how many hundredths of 64?

2. What per cent of 25 is 5?

3. What part of $\frac{1}{2}$ is $\frac{3}{4}$?

Change both to the same denominator: 16 twentieths, 15 twentieths.

4. What part of 2 lb. 1 oz. is 1 lb.?

Change both to the same denomination: 33 oz., 16 oz.

5. Divide 4 gallons by 3 pints.

6. How many pencils at 4 mills each can be bought for a dollar?
1 mill = $\frac{1}{10}$ of a cent.

7. Write $\frac{1}{80}$ as a decimal.

8. Divide 34 by 200.

9. How many pounds in one-quarter of a ton? How many pints in .25 of a bushel?

10. Change $37\frac{1}{2}\%$, 75% , $8\frac{1}{2}\%$, $62\frac{1}{2}\%$, $6\frac{1}{4}\%$, to fractions of a dollar?

11. How many pounds of cheese at \$0.16 $\frac{2}{3}$ a pound can be bought for \$5.00?

12. An agent collected rents amounting to \$300. What was his commission at $\frac{1}{2}\%$?

13. Find the interest of \$200 for 1 yr. 3 mo. at 4%.

14. A farmer raised 50 bushels of cranberries, and sold 60% of them. How many bushels did he sell?

15. What % of a number is $\frac{9}{20}$ of it?

16. What would 42 pounds of butter cost at $33\frac{1}{3}\%$ a pound?

17. When the tax rate is \$12 per \$1000, what will Mr. Smith's tax be if he owns \$4500 worth of property?

18. A man pays \$60 interest per year. How much interest does he pay in 3 yr. 7 mo.?

19. At \$45 per month, what is the rent of a house for 2 yr. 7 mo.?

20. Express in per cents: $\frac{1}{2}$; $\frac{1}{3}$; $\frac{1}{4}$; $\frac{1}{5}$.

275. Written Problems.

1. What is the interest on \$760 for 5 months at $3\frac{1}{2}\%$?
2. A merchant insures property worth \$20,000 for $\frac{3}{4}$ of its value. How much does he pay, the rate for insuring being $1\frac{1}{4}\%$?
3. What is the commission on \$5678 worth of cloth at $2\frac{1}{2}\%$?
4. At 3%, what is the commission on the sale of 5000 pounds of sugar at $5\frac{1}{4}\%$ per pound?
5. What will be the interest on \$720 for 3 mo. 24 da. at $4\frac{1}{2}\%$?
6. A clerk's income is \$800. He pays 25% of it for board, and $33\frac{1}{3}\%$ of the remainder for clothes. How much has he left?
7. $\frac{1}{4}\%$ of my money is in my pocket, 38% is in the bank, and the rest is in real estate. I have in all \$24,000. How much is in the bank and in real estate?
8. An auctioneer sold for Mrs. Paul, on 10% commission, 14 chairs at \$1.75, 6 tables at \$2.75, 40 yards carpet at $62\frac{1}{2}\%$ a yard, and a miscellaneous lot for \$119.24. What sum did Mrs. Paul receive after paying commission?
9. How many feet in $62\frac{1}{2}\%$ of a mile?
What part of a day is 18 hr. 30 min.?
Reduce 9 cwt. 17 lb. to ounces.
10. If .625 of a cord of wood costs \$3.75, what will .75 of a cord cost?

Chapter Four.

11. A business man's receipts for a week are \$2575. His average rate of profit is 5% of his receipts. What is his profit for the week?
12. A certain city had 14,250 inhabitants in 1900. The population has increased 24 per cent. What is the present number of inhabitants?
13. A class has 56 pupils on register. When 14 $\frac{1}{2}$ per cent of the pupils are absent, how many are present?
14. A merchant's sales for 1903 were \$45,276. What should be the sales for 1904 to make an increase of 16 $\frac{1}{4}$ per cent?
15. Thirty words were dictated as a spelling test. One pupil received a mark of 93 $\frac{1}{2}$ per cent. How many words did he misspell?
16. A certain regiment went into battle with 1000 men. Of these 5% were killed, 12% were wounded, 3% were taken prisoners, and 1% were missing. How many remained available for duty?
17. What is the duty at 35 cents per square yard on a piece of cloth measuring 56 yards, 27 inches wide?
18. A man bought a bill of goods amounting to \$374.50, with a deduction of 2% for payment within 10 days. How much does he save by paying the bill within the 10 days?
19. A merchant places a bill of \$840 in the hands of a collector, who collects 75% of the amount. How much does the merchant receive if the collector deducts 5% of the amount collected, as his commission?
20. How many pounds of bread can be made from 5 bushels of wheat weighing 60 pounds per bushel, if the wheat loses 30 per cent in the process of grinding into flour, and if the bread weighs 33 $\frac{1}{3}$ per cent more than the weight of the flour used?

SURFACES.

276. Preliminary Exercises.

1. What is the length in inches of a row of four envelopes, each five inches long, placed end to end? What is the length in feet and inches.

5 inches			
3 inches			

2. What is the width in inches of four such rows, each envelope three inches wide, just touching each other? What is the width in feet?
3. How many envelopes are there? How many square inches are there in each envelope? How many square inches are covered by all of them?
4. How many envelopes 5 inches by 3 inches would cover the top of a table 4 ft. 2 in. long and 2 ft. 6 in. wide?
5. Draw a rectangle to represent a floor 24 feet long 18 feet wide. Draw rugs 6 feet long, 3 feet wide, and see how many will be needed to cover the floor.
6. What is the difference between three square inches and three inches square?
7. What is the distance around a room that is 40 feet by 30 feet?

8. A garden is 12 feet long and 9 feet wide. How many bunches of flowers will it furnish, if it takes 3 square feet to furnish one bunch?

9. A room is 36 feet long and 30 feet wide. How many square yards in the floor?

10. How many yards is it around a room 15 feet long and 12 feet wide?

11. How many square inches in the surface of a sheet of paper 1 foot 8 inches long, 11 inches wide?

12. How many pieces of paper 2 inches square will exactly cover a slate 12 inches long, 8 inches wide?

277. Written Problems.

1. How many boards 12 feet long, 6 inches wide will be required for a floor 8 yards long, 6 yards wide?

The floor is 24 feet long, 18 feet wide; its area in square feet is 18×24 . The area of the board in square feet is $12 \times \frac{1}{2}$, or 6.

$$\text{Number of boards} = \frac{18 \times 24}{6}$$

NOTE. — Labor is frequently saved in examples involving multiplication and division by first indicating the operations and then using cancellation.

2. How many bricks 8 inches by 4 inches will be needed for a walk 24 yards long, 6 feet wide, making no allowance for waste?

Area of top surface of one brick = (8×4) square inches. The length of the walk in inches = $24 \times 3 \times 12$; width in inches = 6×12 . Area of walk in square inches = $24 \times 3 \times 12 \times 6 \times 12$. Divide this by 8×4 , the number of square inches in the top surface of a brick.

$$\text{Number of bricks} = \frac{24 \times 3 \times 12 \times 6 \times 12}{8 \times 4}.$$

NOTE. — It will be remembered that the divisor and the dividend must be of the same denomination, square inches in this example.

3. How many paving tiles $\frac{1}{2}$ foot square will cover a hearth 6 feet long, 3 feet wide?

Make a diagram.

4. How many boards 12 feet long, 8 inches wide will be required for a close fence 120 yards long, 6 feet high?

5. Find the number of paving stones 9 inches by 3 inches, in a street 100 rods long, 10 yards wide.

6. Draw a rectangle 2 inches by 3 inches. Draw one twice the size. What are the dimensions of the latter? What are the dimensions of one four times the size?

A plot 100 feet by 100 feet is how many times as large as a plot 25 feet by 25?

7. A brick is 8 inches long, 4 inches wide, 2 inches thick. How many square inches are there in the surface of the widest face? In the surface of one side? In the surface of one end?

8. How many bricks laid on the widest face will be needed for a walk 288 inches long, 96 inches wide?

9. How many bricks laid on the side will be needed for a walk 24 feet long, 8 feet wide?

10. How many square feet are there in a roll of wallpaper 24 feet long, 18 inches wide?

11. How many rolls 24 feet long, $1\frac{1}{2}$ feet wide, would be required to paper the ceiling of a room 45 feet long, 36 feet wide, making no allowance for matching or waste?

12. The owner of a piece of ground 200 feet wide, 300 feet long, divides it into lots 25 feet by 100 feet. How many lots are there?

13. Make table of square measure:

square inches (sq. in.)	= 1 square foot (sq. ft.)
square feet	= 1 square yard (sq. yd.)
square yards	= 1 square rod (sq. rd.)
160 square rods	= 1 acre (A.)
acres	= 1 square mile (sq. mi.)

14. There are 160 square rods in an acre. How many square yards are there in an acre?

15. Give the dimensions, in yards, of a field that will contain just an acre. Of one that will contain two acres.

16. At \$80 per acre what is the value of a field 80 rods long, 70 rods wide?

What will it cost to fence the field at 20¢ per running yard?

17. A man has a lot 100 feet by 200 feet. How many square feet will he have left for a garden after he builds a house 25 feet by 60 feet?

18. One wall of a room is 24 feet long and 12 feet high. There is a door in it 8 feet high, $4\frac{1}{2}$ feet wide. How many square yards of plastering will be needed to cover the wall?

19. What would be the cost of painting 1800 feet of fence 6 feet high at 15 cents per square yard?

20. What is the length of a rectangular field 60 rods wide that contains 60 acres?

21. A farm is one mile square. How many 40-acre fields does it contain?

22. How many acres in a field in the shape of a triangle whose base and perpendicular measure 40 rods each?

23. How many acres are there in a triangular plot of ground when the base measures 80 yards and the perpendicular measures $60\frac{1}{2}$ yards?

VOLUMES.

278. Preliminary Exercises.

1. How many one-inch cubes can be placed on the bottom of a box 4 inches long, 3 inches wide?

2. If the box is one inch high, how many will it hold? If the box is 2 inches high? 3 inches high?

NOTE. — A cube one inch long, one inch wide, one inch high, contains a cubic inch.

3. How many cubic inches in a box 3 inches long, 4 inches wide, 1 inch high? In a box 3 inches long, 4 inches wide, 2 inches high? In a box 4 inches long, 4 inches wide, 4 inches high?

4. If you had 24 one-inch cubes, how could you pile them to make a solid with six rectangular faces?

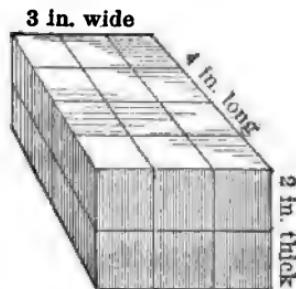
5. If the pile was 2 inches high, how many cubes would there be in each tier? How many square inches would the lower tier cover?

6. How could the 24 cubes be arranged to make a pile 3 inches high?

7. Can you give a rule for finding the number of cubic inches in a box 4 inches long, 2 inches high, 3 inches wide?

8. How many cubic inches of water would a tin box hold, the dimensions of the box being 5 inches by $3\frac{1}{2}$ inches by 4 inches?

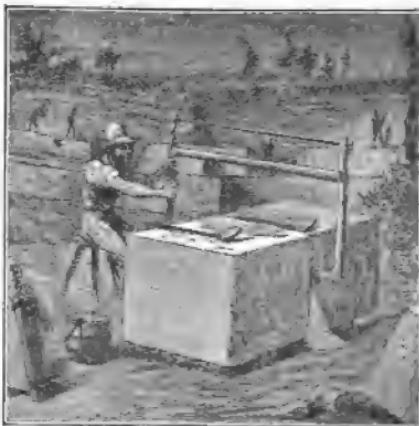
9. How many one-foot cubes could be placed in a cubical box one yard long, one yard wide, one yard high?



279. A solid has three dimensions : length, breadth, and thickness.

The *volume* or contents of a solid, is the space it occupies, expressed in cubic inches, cubic feet, cubic yards, etc.

A *cube* is a solid having six equal square faces.



280. Cubic Measure.

$$1728 \text{ cubic inches (cu. in.)} = 1 \text{ cubic foot (cu. ft.)}$$

$$27 \text{ cubic feet} = 1 \text{ cubic yard (cu. yd.)}$$

281. Written Exercises.

1. How many cubic inches in a solid 3 yards long, 2 feet wide, 6 inches high ? How many cubic feet ? How many cubic yards ?

To find the volume in cubic inches, change 3 yards to 108 inches, and 2 feet to 24 inches.

$$\text{Volume} = (108 \times 24 \times 6) \text{ cubic inches.}$$

$$\text{Volume (in cubic feet)} = (3 \times 2 \times \frac{1}{2}) \text{ cubic feet.}$$

$$\text{Volume (in cubic yards)} = (3 \times \frac{2}{3} \times \frac{1}{2}) \text{ cubic yards.}$$

2. How many cubic feet of air in a room 24 feet long, 18 feet wide, 12 feet high ?

3. Find the solid contents of a piece of timber 25 feet long, 3 feet wide, 5 feet thick. Is it larger or smaller than a piece 4 feet wide, 4 feet thick, and 23 ft. 6 in. long ?

4. How many cubic yards of earth will have to be removed in digging a cellar 18 feet wide, 55 feet long, 6 feet deep? What will be the cost at 60¢ a load (1 cubic yard)?
5. A brick is 8 inches long, 4 inches wide, 2 inches thick. How many bricks are there in a pile 60 feet long, 20 feet wide, 5 feet high?
6. Find the number of bricks in a wall 24 feet wide, 48 feet high, 1 foot thick, making no allowance for mortar, etc.
7. How many bricks are there to a cubic foot?
8. Allowing 20 bricks to a cubic foot when laid in mortar, how many bricks will be needed for a wall 24 feet wide, 50 feet high, 20 inches thick?
9. What will be the cost of building a stone wall 40 rods long, 4 feet high, 1 yard thick, at \$6.40 per perch of $24\frac{1}{4}$ cubic feet?
10. A cord of wood contains 128 cubic feet. If the wood is cut into 4-foot lengths, what should be the other two dimensions of a regular pile to hold just a cord?
11. How many cords of wood are there in a pile 24 feet long, 4 feet wide, 12 feet high?

1 cord = 128 cubic feet.

282. Cubic Measure of Capacity.

231 cu. in. = 1 gallon

2150.4 cu. in. = 1 bushel

128 cu. ft. = 1 cord

12. Find the capacity in bushels of a bin 1 yd. long, 2 ft. 4 in. wide, 5 ft. 4 in. high.



The capacity of a bin, tank, etc., corresponds to the volume of the contents of the bin or tank when full.

Write the dimensions in inches as factors, with the number of cubic inches in a bushel as a divisor, and cancel.

The decimal point in the divisor is moved one place to the right, and a cipher is added to one of the numbers above the line. 21504 is cancelled by 12, 7, 4, and 64.

13. Find the capacity in gallons of a tank 1 ft. 9 in. long, 1 ft. 3 in. wide, 1 ft. 10 in. deep.

$$\frac{21 \times 15 \times 22}{231} \text{ gal. Cancel.}$$

14. How many gallons are there in a cubic foot?

Give the answer as a mixed number; as a mixed decimal.

15. How many cubic feet are there in a bushel?

Give the answer as a mixed number; as a mixed decimal.

16. Give the width of a wagon body 18 inches high, 6 feet long, that will hold, when full, a cubic yard.

17. A gallon contains 231 cu. in. Give the dimensions of a tin box that will hold exactly a gallon.

18. A pile of wood 40 feet long and 12 feet wide contains 1920 cubic feet. How high is it?

19. How much will it cost to have it cut if it costs 80 cents a cord?

20. A pile of 4-foot wood is 16 feet long and 6 feet high. Required the cost at \$ 5.50 per cord.

21. A rectangular tank is 5 feet long, 2 feet wide, and 2 feet deep. How many gallons of water will it hold?

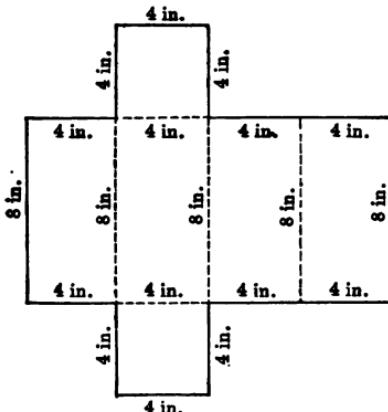
22. What is the cost of digging a cellar 21 feet long, 18 feet wide, and 6 feet deep, at \$.28 a cubic yard?
23. How much will a block of granite weigh 15 feet long, 12 feet wide, and 9 feet thick, if 9 cubic feet weigh 72 lb.?

SURFACES OF RECTANGULAR SOLIDS.

283. Preliminary Exercises.

1. How many faces has a cube?
2. What is the surface of each face of an inch cube?
3. How many square inches are there in all the faces of an inch cube?

The accompanying diagram shows the dimensions of a piece of paper that will exactly cover a square prism, whose base measures 4 inches by 4 inches, and whose height is 8 inches.



4. How many square inches are there in the top face of the prism? In the bottom face? In each of the four side faces? In the four side faces? In the two ends? In the entire surface?

284. Written Exercises.

1. Make a diagram of a piece of paper that when folded will just cover the six faces of a brick $8 \times 4 \times 2$ inches. How many square inches of paper would be needed?
2. The owner of a piece of ground 600 feet long, 150 feet wide, builds a fence 6 feet high around the plot. How many square feet of fence are there?

The surface of this fence may be considered as the four side faces of a solid. The area in square feet = $(150 \times 6) + (600 \times 6) + (150 \times 6) + (600 \times 6)$. The operation is shortened by adding 150, 600, 150, and 600, and multiplying the sum by 6. (1500×6) sq. ft. = 9000 sq. ft., *Ans.*

3. A room is 24 feet long, 18 feet wide, 12 feet high. Draw, touching each other, four rectangles representing the four walls. Write the dimensions of each wall.

What are the dimensions of the large rectangle made up of the four smaller ones? Give the area in square feet. In square yards.

4. Show by a diagram the shape of a piece of paper that when folded will entirely cover a box 12 inches long, 6 inches wide, 4 inches high. Write the dimensions.

This is called the "development" of the box.

What is the area of the paper in square inches?

5. How many square feet are there in a fence 10 feet high enclosing a lot 250 feet long, 200 feet wide?

6. Make a diagram of a room 24 feet long, 18 feet wide, 12 feet high, showing the surface that is generally plastered.

How many square yards of plaster will be needed for the above room, making no allowance for doors, windows, etc.?

7. A box is 4 inches long, 2 inches wide, and 2 inches deep. How many square inches on its surface? With the pen, sketch a free-hand development of this box.

8. One of the drawing models is a square prism 8 inches long and 4 inches square. How many square inches on the whole surface of the model?

9. How many square yards in the walls of a room 12 feet wide, 15 feet long, and 9 feet high?

10. The floor of a room is $18\frac{1}{2}$ feet long, $15\frac{1}{2}$ feet wide. How many square yards in the ceiling?

A lot of land containing 5250 square feet is 125 feet long. How wide is it?

ANGLES, TRIANGLES, QUADRILATERALS.

285. The following may be drawn free-hand, the compasses being reserved for the geometrical problems in Chapter VIII.

1. Draw two lines meeting at a point.

These lines make an *angle*.

2. Draw two lines that will make four angles.

3. Draw two lines so as to make two angles.

Two such angles are called *supplementary angles*.

4. Make two equal supplementary angles.

Equal supplementary angles are called *right angles*. A line making a right angle with another line is said to be *perpendicular* to it.

5. Draw two lines so as to make one right angle.

Is the right angle made by two lines, each 10 feet long, any larger than a right angle made by two lines, each 1 inch long?

6. What is the smallest number of straight lines that will enclose space?

Draw a figure enclosed by the smallest possible number of straight lines. What is its name? Why?

7. Make a triangle having one right angle.

8. Can you draw a triangle having two right angles? Why? What name is given to lines that will not meet, no matter how far they are extended?

9. An angle less than a right angle is called an acute angle.

Draw a triangle containing an acute angle.

10. Can you draw a triangle containing two acute angles? Three acute angles?

11. An angle greater than a right angle is called an obtuse angle.

Draw a triangle containing an obtuse angle.

12. Can you draw a triangle containing three obtuse angles? Containing two?

13. Draw a triangle with sides 2 inches, 3 inches, 4 inches, respectively.

A triangle having no two sides equal is called a *scalene* triangle.

14. Draw a triangle having two equal sides.

This is called an *isosceles* triangle. The unequal side is called the base.

15. Draw an isosceles triangle with the base uppermost. With the base on the left. On the right.

16. Draw a triangle having three equal sides (an equilateral triangle).

17. Draw a square. Draw a rectangle 4 inches by 3 inches.

How many right angles in each?

18. Draw a four-sided figure having its opposite sides parallel, but containing no right angle (rhomboid).

What kinds of angles does it contain? How many of each? Write name in each angle.

19. Draw a four-sided figure, having all its sides equal, but containing no right angle (rhombus).

20. Draw a quadrilateral (four-sided figure) having only two parallel sides (trapezoid).

21. Draw a quadrilateral having no parallel sides (trapezium).

22. Draw a rhombus, each side 2 inches. A square, each side 2 inches.

What is the difference between them? Which is larger?

23. A parallelogram is a quadrilateral that has its opposite sides parallel.

Name the parallelograms that have four equal sides (equilateral). Those that have four equal angles (equiangular).

24. The height of a parallelogram is called its altitude. Draw a rectangle, base $3\frac{1}{2}$ inches, altitude $2\frac{1}{2}$ inches. Draw a rhomboid, base $3\frac{1}{2}$ inches, altitude $2\frac{1}{2}$ inches. Draw several rhomboids of the above dimensions, all differing in shape.

25. Cut out of paper a rectangle, base 3 inches, altitude 2 inches. Cut out a rhomboid, base 3 inches, altitude 2 inches. Place one upon the other, and see how their areas compare.

26. Can you calculate the number of square inches in a rhomboid whose base is 3 inches and altitude 2 inches?

27. Draw a rectangle, base 4 inches, altitude 3 inches. Divide by a diagonal into two triangles. Mark in each triangle its area.

28. Draw a right-angled triangle, base 4 inches, perpendicular (altitude) 3 inches. Calculate its area.

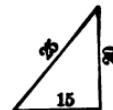
29. Draw a rectangle, base 4 inches, altitude 3 inches. From the middle point of the upper base draw lines to the extremities of the lower base, making three triangles. Mark in each triangle its area.

30. Draw an isosceles triangle, base 4 inches, altitude 3 inches, and calculate its area.

286. Areas of Triangles and Quadrilaterals.

Find the areas of the following:

1. A right-angled triangle whose sides measure 15, 20, and 25 inches respectively.



NOTE. — Area of triangle = $\frac{1}{2}$ product of base by altitude (perpendicular).

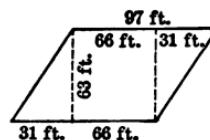
2. A right-angled triangle whose base measures 64 yards, perpendicular 48 yards.

3. A triangle whose base measures 18 rods, altitude 13 rods.

4. A square whose side measures 35 feet.

Area of parallelogram = base \times altitude.

5. A rectangle 42 yards by 37 yards.

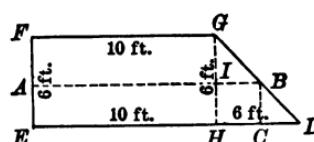


6. A rhombus whose base is 97 feet, altitude 63 feet.

Show that the area of this parallelogram is equal to that of a rectangle 97 feet by 63 feet.

7. A rhomboid, base 33 meters, altitude 28 meters.

8. A trapezoid whose parallel sides measure 10 and 16 feet, respectively, the perpendicular distance between them being 6 feet.



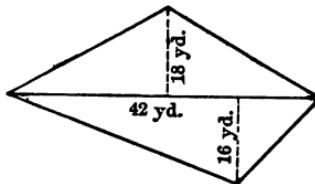
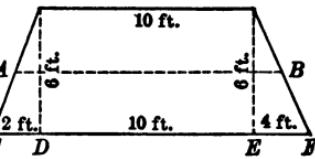
Draw this trapezoid on a scale of $\frac{1}{2}$ inch to the foot, and measure AB , which divides the rectangle $EFGH$ into two equal parts. $AB = \frac{1}{2}(FG + ED)$. Cut off the triangle BCD and add it to the upper half of the trapezoid, so that CD will be a continuation of FG . The rectangle thus formed should measure 13 feet by 6 feet.

9. A trapezoid as shown in the accompanying diagram.

Draw to a scale; cut off a triangle from A to the centre of CD , also one from B to the centre of EF ; and place these triangles above AB , so as to make a rectangle, $\frac{1}{2}(10 + 16)$ feet long and 6 feet wide.

10. A trapezium, one of whose diagonals measures 42 yards, the perpendiculars to the opposite corners measuring 18 yards and 16 yards, respectively.

Area in square yards = $(42 \times \frac{1}{2} \text{ of } 18) + (42 \times \frac{1}{2} \text{ of } 16) = 42 \times \frac{1}{2} \text{ of } (18 + 16)$.



SPECIAL DRILLS.—REVIEW.

287. Oral Exercises.

$$1. 463 + 157 = 463 + 100 + 50 + 7 =$$

In giving the solution at sight, the pupil says (or thinks) 563, 613, 620.

$$2. 256 + 184$$

$$4. 185 + 546$$

$$6. 167 + 734$$

$$3. 419 + 342$$

$$5. 668 + 193$$

$$7. 476 + 155$$

$$8. 4170 + 470 = 4170 + 400 + 70$$

Use no unnecessary words: 4570, 4640.

$$9. 1260 + 850$$

$$11. 3450 + 390$$

$$13. 5620 + 590$$

$$10. 2140 + 680$$

$$12. 4370 + 280$$

$$14. 6380 + 660$$

$$15. 400 - 163 = 400 - 100 - 60 - 3 =$$

Say only 300, 240, 237.

- | | | |
|---|---|---|
| 16. $501 - 375$ | 18. $650 - 488$ | 20. $361 - 149$ |
| 17. $275 - 137$ | 19. $540 - 384$ | 21. $455 - 358$ |
| 22. $7310 - 6850 = 7310 - 6800 - 50 =$ | | |
| 510, 460. | | |
| 23. $8610 - 7680$ | 25. $4960 - 4380$ | 27. $6450 - 5760$ |
| 24. $5000 - 4670$ | 26. $2770 - 1890$ | 28. $7320 - 6560$ |
| 29. $24 \times 66\frac{2}{3} = \frac{2}{3}$ of 24 hundred. | | |
| 30. $48 \times 16\frac{2}{3}$ | 33. $24 \times 62\frac{1}{2}$ | 36. 28×75 |
| 31. $32 \times 37\frac{1}{2}$ | 34. $36 \times 66\frac{2}{3}$ | 37. $40 \times 87\frac{1}{2}$ |
| 32. 49×25 | 35. $39 \times 33\frac{1}{3}$ | 38. $88 \times 12\frac{1}{2}$ |
| 39. $533\frac{1}{2} + 66\frac{2}{3} = 5\frac{1}{2}$ hundred + $\frac{2}{3}$ hundred = 16 + 2. | | |
| 40. $337\frac{1}{2} \div 37\frac{1}{2}$. | 42. $687\frac{1}{2} \div 62\frac{1}{2}$ | 44. $437\frac{1}{2} \div 87\frac{1}{2}$ |
| 41. $733\frac{1}{2} + 33\frac{1}{3}$ | 43. $933\frac{1}{2} \div 66\frac{2}{3}$ | 45. $212\frac{1}{2} \div 12\frac{1}{2}$ |

288. Oral Problems.

1. How many ounces in $11\frac{5}{8}$ pounds?
2. 258 yards equal how many feet?
3. A dealer bought 652 tons of coal and sold 476 tons. How much had he left?
4. Sold my wheat for \$347 and my oats for \$154. How much did I receive for both?
5. $40\frac{3}{8}$ yards of ribbon are cut into 7 pieces. Find the length of each piece.
6. How many square yards in a floor $5\frac{1}{2}$ yards long and $5\frac{1}{2}$ yards wide?
7. What will be the cost of 14 pounds of lard at $14\frac{1}{2}\frac{\dollar}{lb}$ per pound?
8. At $1\frac{1}{2}\frac{\dollar}{doz}$ each, how many lead pencils can I buy for $27\frac{1}{2}\frac{\dollar}{}$?

9. What part of a 196-pound barrel of flour is contained in a 49-pound bag?
 10. At $45\frac{1}{2}$ per yard, how much lace can be bought for \$1.35?
 11. A woman has saved \$833. How much more must she save to have \$1000?
 12. What will be the cost of 16 pounds of sugar at $4\frac{1}{2}\frac{1}{2}$ per pound?
 13. Spent \$2.56 for dry goods and \$1.84 for groceries. How much did I spend for both?
 14. Find the cost of 3 lb. 10 oz. butter at 32¢ per pound.
 15. At \$.375 per yard how much ribbon can be bought for \$.75?
 16. If it takes $1\frac{1}{4}$ yards of cloth to make a jacket, how many can be made from a piece of cloth containing 30 yards?
 17. A boy paid 35¢ for the use of a boat for $3\frac{1}{2}$ hours. What was the price per hour?
 18. If 13 pounds of raisins cost \$1.69, what is the cost of 1 pound?
- APPROXIMATIONS.**
289. Give an estimate of the answer:
 1. If 3 T. 1988 lb. coal cost \$19.97, what will be the cost of 8 T. 1 lb.?
Nearly 4 tons cost nearly \$20.
 2. At \$500 per year, what will be the rent of a house for 1 yr. 11 mo. 29 da.?
Nearly 2 years.
 3. Find the cost of 5 barrels sugar, averaging 299 pounds each, at $4\frac{1}{2}\frac{1}{2}$ per pound.
4. What is the interest on \$199.86 at 6%, for 5 mo. 28 da.?

Chapter Four.

5. If 11 men and 2 boys can finish a piece of work in $23\frac{1}{2}$ days, how long will it take 23 men and 5 boys?
6. What decimal of 639 acres is 321 acres?
7. What will be the cost of 20,060 bricks at \$ 4.90 per M?
8. A farmer sells 5484 pounds rye at 87¢ per bushel of 56 pounds. How much does he receive?
9. If 19 lb. 15 oz. of tea cost \$ 7.95, what will be the cost of 21 lb. 1 oz.?
10. Paid freight on 1987 pounds at 70¢ per cwt. How much did I pay?
11. If there are about $7\frac{1}{2}$ gallons to a cubic foot, estimate the number of gallons in a tank 5 feet long, 3 feet wide, 4 feet high.
12. If there are about $1\frac{1}{4}$ cubic feet in a bushel, estimate the contents in bushels of a bin 5 ft. \times 3 ft. \times 4 ft.
13. Give the dimensions of a tank of 150 gallons' capacity.
14. Give the dimensions of a bin that will hold 100 bushels.
15. At 20 bricks laid in mortar to the cubic foot, give the length and the height of a wall 1 foot thick that can be built with a thousand bricks.
16. At \$1 a load (1 cubic yard), give the dimensions of an excavation that can be made for \$100.
17. A cubic foot of water (about $7\frac{1}{2}$ gallons), weighs $62\frac{1}{2}$ pounds. About what does a gallon weigh? A pint?
18. If iron is about $7\frac{1}{2}$ times as heavy as water, about what does a cubic foot of iron weigh?
19. About what is $49\frac{1}{4}\%$ of \$801?
20. About what will be the interest at 6 per cent on \$100 for 3 yr. 11 mo. 29 da.?

FUNDAMENTAL PROCESSES.

- 290.** 1. The sum of two numbers is 278. One of the numbers is 89. What is the other?

$$89 + ? = 278$$

2. The minuend is 583, the remainder is 249. What is the subtrahend? $583 - ? = 249$

3. The subtrahend is 56, the minuend is 214. Find the remainder.

4. The difference between two numbers is 84, the smaller is 129. What is the larger number?

5. The subtrahend is 176, the remainder is 92. Find the minuend.

6. The multiplier is 98, the multiplicand is 809. Find the product.

7. The product is 9045, the multiplier is 45. What is the multiplicand?

8. The product of two factors is 1767. One of the factors is 93. Find the other factor.

9. The multiplicand is 84, the product is 2100. What is the multiplier?

10. The dividend is 10,000, the divisor is 275. Find the remainder.

11. The quotient is 32, the remainder is 21, the divisor is 40. What is the dividend?

$$\begin{array}{r} 40) \underline{?} \\ 32 \frac{1}{4} \end{array}$$

12. The dividend is 4263, the quotient is 203. Find the divisor.

$$\underline{4263} = 203$$

13. The dividend is 267, the quotient is 13, the remainder is 7. What is the divisor?

$$\frac{267}{?} = 13 \frac{7}{?}$$

RATIO.**291. Sight Exercises.**

$$\begin{array}{llll} 1. \frac{87 \times 25}{75} & 3. \frac{63 \times 19}{21} & 5. \frac{47}{15} \times 75 & 7. \frac{39}{11} \times 55 \\ 2. \frac{74 \times 24}{37} & 4. \frac{96 \times 27}{32} & 6. \frac{65}{14} \times 42 & 8. \frac{23}{8} \times 32 \end{array}$$

292. Written Exercises.

Indicate operations, and cancel where possible. Terms compared should be of the same denomination.

1. If 90 tons of coal cost \$472.50, what will be the cost of 132 tons ?
$$\frac{\$472.50 \times 132}{90}$$

2. If 3 lb. 4 oz. tea cost \$1.95, what will 12 oz. cost ?

The ratio is 12 oz. to 52 oz.

3. A party of men can build 16 rd. 2 ft. of wall in 20 days. How long will it take them to build 4 yd. 6 in. ?

Change to inches.

4. What will be the cost of 3 bu. 2 pk. 7 qt. of oats if 7 bu. 1 qt. cost \$4.50 ?

5. By travelling at the rate of 20 miles a day, a person can complete a journey in 18 days. At what rate must he travel to finish it in 15 days ?

6. How many rolls of merino, each containing 75 yards, worth \$.45 per yard, will it take to pay for 180 yards of alpaca at \$.30 per yard ?

7. A merchant sold 20 hogsheads of oil, each containing 63 gallons, at \$1.75 per gallon, and invested the proceeds in table sauce in cases of 12 bottles each, worth \$.31 $\frac{1}{4}$ per bottle. How many cases did he buy ?

8. No allowance being made for mortar, how many bricks will be required to build a wall 50 feet long, 4 feet high, and 1 foot 3 inches thick, each brick being 8 inches long, 4 inches wide, and $2\frac{1}{2}$ inches thick?
9. If .1875 of a vessel cost \$273.12 $\frac{1}{2}$, what is the value of $\frac{5}{82}$ of it at the same rate?
10. What is the cost of 60.51 tons of coal, when .9 of a ton costs \$6.66?

REVIEW OF FRACTIONS.

293. Add across:

If the pupils work from their books the following examples in addition and subtraction, they should be permitted to write only the answers. The teacher should announce the number of an example, not taking them in order, then the number of the next to be worked, without giving time for the writing of unnecessary figures.

1. $13\frac{1}{2} + 16\frac{4}{5} + 8\frac{3}{4}$	6. $59\frac{5}{7} + 3\frac{1}{2} + 4\frac{3}{4}$
2. $4\frac{1}{4} + 5\frac{2}{3} + 27\frac{8}{9}$	7. $7\frac{6}{7} + 18\frac{2}{3} + 40\frac{1}{8}$
3. $19\frac{1}{8} + 3\frac{5}{6} + 35\frac{1}{5}$	8. $35\frac{2}{3} + 51\frac{1}{8} + 8\frac{7}{10}$
4. $8\frac{1}{2} + 9\frac{3}{10} + 14\frac{1}{6}$	9. $3\frac{7}{8} + 9\frac{1}{3} + 25\frac{7}{12}$
5. $23\frac{3}{8} + 5\frac{1}{4} + 32\frac{5}{12}$	10. $66\frac{1}{2} + 8\frac{2}{3} + 14\frac{1}{5}$

294. Subtract across:

11. $25\frac{1}{4} - 18\frac{7}{12}$	16. $68\frac{8}{9} - 61\frac{1}{2}$
12. $63\frac{2}{5} - 49\frac{3}{8}$	17. $100\frac{1}{3} - 62\frac{1}{4}$
13. $70\frac{4}{11} - 15\frac{1}{7}$	18. $56\frac{1}{4} - 37\frac{2}{3}$
14. $92\frac{4}{5} - 24\frac{7}{8}$	19. $83\frac{3}{8} - 43\frac{2}{5}$
15. $33\frac{1}{3} - 15\frac{7}{10}$	20. $42\frac{1}{2} - 16\frac{1}{4}$

295. Multiply:

When the fractions are small and the fraction in the multiplicand has 1 for its numerator, business men do not change the mixed numbers to improper fractions.

In multiplying $38\frac{1}{4}$ by 11, the product of $\frac{1}{4}$ by 11 is mentally reduced to $8\frac{1}{4}$, and $\frac{1}{4}$ written; 11 eights (88), and 8 (96), 6 being written; etc. $\frac{1}{4}$ of $38\frac{1}{4}$ is 4 (written) with $6\frac{1}{4}$ remainder. This is reduced to $1\frac{1}{4}$ mentally, and its $\frac{1}{4}$, or $\frac{1}{4}\frac{1}{4}$, written.*

$$\begin{array}{r} 37\frac{1}{2} \times 3\frac{1}{2} \\ \hline 112\frac{1}{2} \\ 18\frac{1}{4} \\ \hline 131\frac{1}{4} \end{array} \text{Ans.}$$

$$\begin{array}{r} 12\frac{1}{4} \times 5\frac{1}{2} \\ \hline 63\frac{1}{4} \\ 4\frac{1}{4} \\ \hline 68 \end{array} \text{Ans.}$$

$$\begin{array}{r} 38\frac{1}{4} \times 11\frac{1}{2} \\ \hline 426\frac{1}{4} \\ 4\frac{1}{4}\frac{1}{2} \\ \hline 431\frac{3}{4} \end{array} \text{Ans.}$$

21. $48\frac{1}{4} \times 4\frac{1}{2}$

24. $18\frac{1}{2} \times 5\frac{1}{2}$

27. $45\frac{1}{2} \times 2\frac{1}{2}$

22. $64\frac{1}{2} : 10\frac{1}{2}$

25. $13\frac{1}{4} \times 7\frac{1}{2}$

28. $50\frac{1}{2} \times 10\frac{1}{2}$

23. $29\frac{1}{2} \times 6\frac{1}{4}$

26. $9\frac{1}{4} \times 8\frac{1}{2}$

296. Divide:

29. 13)205 $\frac{1}{4}$

The pupil should endeavor to work the following by short division: 13 into 20, once; into 75, 5 times, remainder $10\frac{1}{4}$ or $4\frac{1}{4}$; $\frac{1}{13}$ of $4\frac{1}{4}$ = $\frac{1}{5}$.
Ans. 15 $\frac{1}{4}$.

30. 14)186 $\frac{1}{4}$

37. 21)450 $\frac{1}{4}$

44. 25)568 $\frac{1}{4}$

31. 15)250 $\frac{1}{4}$

38. 31)970 $\frac{1}{4}$

45. 32)965 $\frac{1}{4}$

32. 16)198 $\frac{1}{4}$

39. 24)553 $\frac{1}{4}$

46. 36)722 $\frac{1}{4}$

33. 17)190 $\frac{1}{4}$

40. 23)466 $\frac{1}{4}$

47. 16)366 $\frac{1}{4}$

34. 18)200 $\frac{1}{4}$

41. 26)290 $\frac{1}{4}$

48. 17)208 $\frac{1}{4}$

35. 19)381 $\frac{1}{4}$

42. 27)545 $\frac{1}{4}$

49. 21)640 $\frac{1}{4}$

36. 22)264 $\frac{1}{4}$

43. 33)999 $\frac{1}{4}$

50. 22)888 $\frac{1}{4}$

REVIEW OF DECIMALS.**297. Sight Exercises.**

Give products:

- | | | |
|----------------------|---------------------------------|----------------------------------|
| 1. $360 \times .25$ | 8. $840 \times .075$ | 15. $400 \times .04$ |
| 2. $560 \times .125$ | 9. $960 \times .005$ | 16. $165 \times .06\frac{1}{4}$ |
| 3. $240 \times .375$ | 10. $1200 \times .001$ | 17. $176 \times .06\frac{1}{4}$ |
| 4. $400 \times .625$ | 11. $1500 \times .002$ | 18. $3300 \times .00\frac{1}{4}$ |
| 5. $480 \times .75$ | 12. $96 \times .3\frac{1}{2}$ | 19. $880 \times .12\frac{1}{2}$ |
| 6. $320 \times .875$ | 13. $840 \times .02\frac{1}{2}$ | 20. $105 \times .8$ |
| 7. $720 \times .025$ | 14. $1500 \times .06$ | 21. $210 \times .10$ |

298. Give quotients:

- | | | |
|--------------------|------------------------------|------------------------------|
| 1. $240 \div .5$ | 8. $37 \div .05$ | 15. $76 \div .04$ |
| 2. $360 \div .75$ | 9. $48 \div .005$ | 16. $88 \div .00\frac{1}{4}$ |
| 3. $45 \div .125$ | 10. $72 \div .025$ | 17. $65 \div .12\frac{1}{2}$ |
| 4. $23 \div .25$ | 11. $92 \div .002$ | 18. $84 \div .8$ |
| 5. $360 \div .375$ | 12. $93 \div .03\frac{1}{2}$ | 19. $11 \div .06\frac{1}{4}$ |
| 6. $100 \div .625$ | 13. $54 \div .02\frac{1}{2}$ | 20. $42 \div .6\frac{1}{4}$ |
| 7. $154 \div .875$ | 14. $132 \div .06$ | 21. $93 \div .5$ |

299. Written Exercises.

- Find the value of $(6.125 + 8.75 - 9.1235) \div .0125$.
- Find the value of $(1708.4592 \div .00024) \times .003$.
- Simplify $\frac{7 - 3.004}{.2 + 7.3} \times \frac{5 - .08}{4.8} + 1\frac{1}{2}$.
- Multiply 24.234 by .346, and write the result in words.
- Divide 96 ten-thousandths by 384 hundred-millionths.

6. Why does the value of a decimal remain unchanged when ciphers are annexed?

7. Write: four hundred seven thousandths.

8. Write: six hundred four millionths.

9. Write in words 405.0067542.

10. Reduce to common fractions in lowest terms:

.004; .0125; 56.37 $\frac{1}{2}$.

11. $16\frac{1}{4} \times .045 = ?$ $.324 \times .33\frac{1}{3} = ?$ $3.406 \times 1.00 = ?$

12. $.805 + .35 = ?$ $80.5 + 350 = ?$ Divide twenty-five thousandths by 16 millionths.

13. Write in words:

.0105; 000125; 1.001105; 11.4141; .000008.

14. Reduce to common fractions: .95; .526.

15. From one thousand and (decimal) five thousandths take eight hundred and (decimal) eight hundredths.

16. Divide eight hundredths by four thousandths, and multiply the quotient by six ten-thousandths.

17. Find the product of the following factors: .064, .0032, 15,625, and 31.25.

300. Oral Review Problems.

1. At 20¢ per quart, what will be the cost of 2 gal. 3 qt. 1 pt. of maple syrup?

2. Find the cost of 4 T. 400 lb. of coal at \$5 per ton.

3. A man puts 4 lb. 8 oz. of tea into 9-ounce packages. How many packages does he make?

4. 4 pk. 3 qt. of apples are given to some children. If each child's share is 5 quarts, how many children are there?

5. If it takes 3 hr. 20 min. to hoe a row of corn, how many rows can a man do in 2 days of 10 hours each?

6. How many dozen eggs at 25¢ a dozen must be given for 100 pounds of sugar at 5¢ a pound?
7. Which would you rather have, $\frac{7}{8}$ of a dollar or 75¢? Why?
8. What will a gallon of molasses cost if a gill costs 2½¢?
1 gill = $\frac{1}{4}$ pint
9. Give the names to the results in the four simplest processes in arithmetic.
10. \$15 per week is how much per day?
11. $\frac{5}{6}$ of 72 is $\frac{3}{4}$ of what number?
12. How many cubic feet in $\frac{3}{4}$ of a cubic yard?
13. Which is the larger and how much larger, $\frac{5}{6}$ of 130 or $\frac{4}{5}$ of 119?
14. Which is the larger and how much, $\frac{5}{6}$ or $\frac{3}{4}$?
15. How many cubic feet in a wall 30 feet long, 4 feet high, and 2 feet thick?
16. If $\frac{5}{6}$ of a barrel of flour cost \$2.13, what cost $1\frac{1}{2}$ barrels?
17. The difference between 144 and 24 is how many times 15?
18. John walked $12\frac{1}{4}$ miles, and Henry $10\frac{5}{8}$ miles. How much farther did John walk than Henry?
19. At $4\frac{1}{2}$ ¢ a pint, what will 5 qt. 1 pt. of milk cost?
20. After spending $\frac{2}{5}$ of his money, James has \$150 left. What amount did he have at first?
21. How many gallons in 462 cubic inches?
22. If a boy eats $\frac{2}{3}$ of a loaf of bread, how many boys will be required to eat 10 loaves?
23. 5 yd. cloth cost 90¢; find the cost of $\frac{2}{3}$ yd.
24. If $\frac{2}{3}$ yd. of cloth costs 10¢, how many yards can be bought for 80¢?

25. A step is 3 feet. 2 steps are what part of a rod?
26. $19 + 3 + 17 + 6 + 15 + 4 = ?$
27. John had 85¢. He bought strawberries for 22¢; 1 pound coffee for 30¢; 3 sheets paper at 1¢ a sheet. What remained?
28. Three-fourths of a mince pie is worth 18¢, and James eats $\frac{1}{4}$ of a pie. What is the value of what he eats?
29. If I have 1 pk. 2 qt. 1 pt. of meal, how many more quarts must there be to make 1 bushel?
30. Charles caught 12 fish, worth $4\frac{1}{2}$ ¢ each, in four hours. His time was worth 12¢ an hour. Gain or loss, and how much?
31. How many times would a dish holding $\frac{3}{4}$ of a pint have to be filled to measure 9 quarts?
32. If 5 chairs cost \$80, what will 12 chairs cost?
33. How many hours from 4 A.M. to 8 P.M.?
34. Reduce $\frac{11}{12}$ to lowest terms.
35. Add $\frac{1}{2}$ to $\frac{3}{4}$, and take the sum from 5.

301. Written Review Problems.

1. What part of 6 hr. 54 min. are 3 hr. 15 min.?
2. If a man walks at the rate of 3 mi. 96 rd. per hour, how far will he walk in 3 hr. 20 min.?
3. What is one-ninth of 28 bu. 3 pk. 7 qt.?
4. Three men buy a house for \$1200. A furnishes \$600; B, \$400; C, \$200. They sell the house for \$1500. How much money should each receive?
5. If 5 T. 1000 lb. of coal cost \$30.25, how much will be paid for 7 T. 320 lb.?
6. At 25¢ per hour, how much should a man receive that works 8 hours and 36 minutes? *

7. If 2 lb. 4 oz. of tea cost \$1.35, what will be the cost of 11 lb. 12 oz.?

8. How many square inches in a paving tile 6 inches square? How many square inches in a rectangle 4 feet by 3 feet? How many paving tiles 6 inches by 6 inches would cover a surface 4 feet by 3 feet?

9. A man buys a house and lot for \$3000. He pays $\frac{2}{3}$ of the amount in cash and the remainder after 1 year, 4 months, with 5% interest. Find the amount of the second payment.

10. Find four-ninths of 28 bu. 3 pk. 7 qt.

11. ($\frac{2}{3}$ of $\frac{7}{8}$) + ($\frac{3}{5}$ of $\frac{9}{10}$) - ($\frac{4}{5}$ of 2) = ?

$$12. \frac{\frac{1}{2} \text{ of } 7\frac{1}{2}}{\frac{3}{8} \text{ of } 15} - \frac{\frac{1}{10} \text{ of } 4\frac{3}{4}}{1\frac{1}{2} \times 11} = ?$$

13. Add $8\frac{5}{7} + \frac{3}{7} + \frac{5}{8} + \frac{8}{11} + \frac{3}{5}$.

14. Find the value of $728 - \frac{3}{4} - \frac{1}{2} - \frac{2}{3} - \frac{1}{4}$.

15. $1\frac{1}{2} \times (\frac{3}{4} + \frac{2}{3}) \times \frac{1}{5}$.

16. Reduce $\frac{7}{10}$ of $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{13.5}{7}$ to a decimal.

17. A person owning $\frac{6}{10}$ of a factory sells 75 per cent of his share for \$1710. What is the value of the whole factory?

18. Find $\frac{2}{3}$ of 2 da. 5 hr. 40 min.

19. If a piece of cloth is 20 yards long and $\frac{1}{4}$ yard broad, how broad is another piece which is 12 yards long and contains as many square yards as the first?

20. Simplify $\frac{2\frac{1}{2} + 1\frac{1}{3}}{2\frac{1}{2} - 1\frac{1}{3}} \times \frac{1\frac{7}{12} - 1}{\frac{1}{4} + \frac{5}{6}}$.

21. If 7 men can do a piece of work in $10\frac{1}{2}$ days, how long will it take 8 men and 5 boys to do the same work, each boy doing one-half as much as a man?

22. A farmer drew to market three loads of wheat, weighing respectively 2873 pounds, 3027 pounds, and 2911 pounds. At 93¢ per bushel (60 pounds), how much did he receive for the three loads?
23. How many acres of land are there in a rectangular farm $\frac{1}{2}$ of a mile long and $\frac{2}{3}$ of a mile wide? (1 square mile = 640 acres.)
24. Reduce $\frac{2\frac{1}{2}}{8\frac{1}{2}} \div \frac{4\frac{1}{2}}{3\frac{1}{2}}$ to a simple fraction.
25. The sum of two numbers is $15\frac{3}{4}$, and one of them is $9\frac{1}{10}$. Find the other number.
26. If 3 be added to both terms of the fraction $\frac{5}{8}$, will the value be increased or diminished, and how much?
27. Make and solve a problem to illustrate reduction descending; one to illustrate reduction ascending.
28. How is the value of a fraction changed by increasing its denominator? Why?
29. Add $\frac{3}{4}$ hours, $20\frac{3}{4}$ minutes, and 49.2 seconds. Express the answer in minutes and seconds.
30. What fractional part of $31\frac{3}{5}$ is $12\frac{1}{2}$?
31. In a hotel the weekly wages of the clerk are \$15, of the cook \$7.50, of the porter \$9, of the waiter \$3, of the hostler \$6, and of the errand boy \$4. Find the average wages paid.
32. A man was born May 24, 1832. What is his age to-day?
33. A grocer's bill for \$84.36 is paid 8 months 15 days after it becomes due, with interest at 5%. How much is paid?
34. Find the cost of 7 lb. 11 oz. of cheese at 13¢ per pound.

35. Find the cost of digging a cellar 30 feet long, 15 feet wide, and 5 feet deep, at 30¢ per cubic yard.

36. John Smith bought of Clark and Jones,

4 lb. 13 oz. beefsteak @ 21¢ per lb.

12 lb. of bacon @ 12½¢.

Make a properly receipted bill of the above, dated at the time and place of this lesson.

37. Find the cost of 2315 pounds of coal at \$5.75 per ton.

38. Write 1249 in Roman notation.

39. Given the dividend 807 and the quotient 34½, find the divisor.

40. What will it cost to fill a jug, which contains 2310 cubic inches, with vinegar at 7 cents a quart?

(1 gal = 231 cu. in.)

41. Mrs. C. B. Jones bought of Cole, Steele, & Co., of Indianapolis, as follows: Nov. 12, 1904, 23 yards of muslin @ 16¾¢; 45 yards of sheeting @ 12½¢; Dec. 7, 12 yards of silk @ \$1.62½¢; 8 handkerchiefs @ 45¢; 2 pairs kid gloves @ \$1.37½; 6 neckties @ 75¢. Make out and receipt the above bill.

42. If a boy bought $\frac{4}{5}$ of a bushel of nuts for \$2.00, and sold them for 12¢ a quart, what was his gain?

43. Reduce $\frac{5}{12}$ of an inch to the fraction of a rod.

44. Reduce 35 quarts to the fraction of a barrel (31½ gal.).

3450 cubic feet to cubic yards.

45. Put the following in the proper form of a bill, find the amount of the bill, and receipt it:

David Wilson bought of Harry Lloyd, June 10, 1904, 7 pounds of oatmeal at 6¢ a pound; 10 pounds of sugar at 7½¢ a pound; 14 pounds of ham at 13½¢ a pound; 3 brooms at \$2.25 a dozen.

46. A family uses 2 quarts of milk a day. At 24¢ a gallon, what does the milk cost for May and June?

47. From March 3d to Sept. 19th is how many days? Do you include one of the days mentioned, or both of them, or neither of them?

48. How many minutes from 8.10 A.M. to 9.25 P.M.

49. Subtract 40 rd. 3 yd. 2 ft. from 81 rd. 1 yd., and multiply the remainder by 10. Work by compound subtraction and multiplication, and get an answer that contains no fraction.

50. Draw and divide a figure so as to show how many square feet in a rectangle that is 5 feet long and 3 feet wide. Draw and divide a figure so as to show how many square inches in a surface that is 4 inches square. These drawings are to be free-hand, and made with your pen.

51. Reduce 7 months and 15 days to the decimal of a year (360 days).

52. Reduce .32175 of 1 ton to whole numbers of lower denominations.

53. If the perimeter of a square is 10 rods, what is the area?

Find the area of a field, whose parallel sides measure 20 and 30 rods, respectively, the perpendicular distance between them being 15 rods.

54. Bought 5 bushels of berries for \$5 and sold them at \$.20 a quart. How much did I gain?

55. From a tract of land 15 rods square I sold 65 square rods. What was the value of the remainder at \$20 an acre?

56. What is the cost of fencing a lot 9 rods square at \$.12 a foot?

57. How many square yards are there in the walls of a room 20 feet long, 18 feet wide, and 9 feet high?

58. What must I pay for the laying of a sidewalk 6 rods long and 5 feet wide at \$.45 a square yard?

59. How much will it cost to plaster a room 18 feet long, 15 feet wide, and 9 feet high, at \$.17 a square yard, deducting 108 square feet for doors and windows?

60. Mr. Thompson has a field, around which he wishes to build a tight board fence. The field is 50 rods long and 45 rods wide. The fence is to be $4\frac{1}{2}$ feet high. At $3\frac{1}{2}$ ¢ a square foot, what will be the cost of the fence?

61. A man having \$100 went to market. He sold 10 bushels of potatoes at 80¢ per bushel, 2 tons of hay at \$15 per ton, and 25 bushels of oats at 45¢ per bushel. He bought 15 barrels of flour at \$4.50 per barrel, and 12 yards of broadcloth at \$4.75 per yard. How much money did he have left?

62. Cost of a pile of wood 10 feet long, 4 feet wide, and $4\frac{1}{2}$ feet high, at \$7.50 a cord?

I wish to pile 60 cords of wood in such a manner that it will be 4 feet wide and 6 feet high. How long must it be?

63. Find the interest of \$263.75 for 1 year, 3 months, 20 days, at 6%.

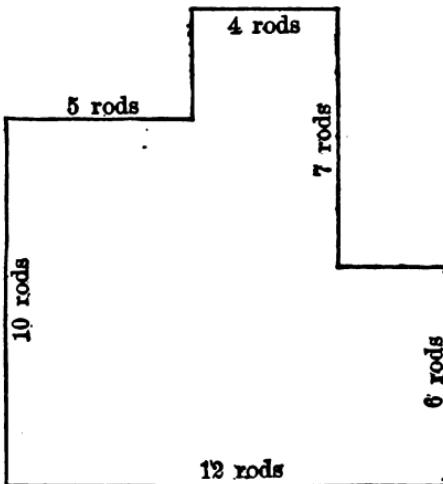
64. At \$17.625 a ton, how many tons of hay can be purchased for \$95?

65. Mr. Ames owns $\frac{11}{22}$ of an acre of land. Mr. Jones owns $\frac{1}{2}$ as much, which is $\frac{1}{2}$ of what Mr. Brown owns. What part of an acre does Mr. Brown own?

66. Four men built a barn. A worked 2 days; B, 6 days; C, 8 days; and D, 12 days. They received \$84. What was each man's share?

67. A man has 768 hens, which is $\frac{1}{2}$ more than he had last year. How many had he then?
68. Two trains are $87\frac{1}{2}$ miles apart and running toward each other, one at the rate of $50\frac{3}{4}$ miles an hour, and the other at the rate of $20\frac{1}{2}$ miles an hour. How far apart will they be in half an hour?
69. If 35 men earn \$87.50 in 1 day, how much will 50 men earn in 10 days?
70. Multiply 9008 by 7080, and divide the product by 600.
71. What is the difference between 69×58.8 and $291 + 0.97$?
72. Find $6\frac{1}{4}\%$ of 19,712 miles.
 $62\frac{1}{4}\%$ of 2768 yards.
 $9\frac{1}{11}\%$ of 11,223,344 pounds.
73. What is the interest of \$150 for 2 yr. 8 mo. 15 da., at 6% per annum.
74. Add: 25,037.45; 8,712.23; 9050.37; 815.25; 91,017.16; 419.19; 2035.75; 15,025.55; 7079.13; 14026.27.
75. Add: 87.27; 43.75; 72.50; 39.75; 64.04; 58.94; 95.83; 26.37; 75.96; 50.83; 39.49; 97.08; 62.62.
76. A lot of land containing 5250 square feet is 125 feet long. What is the perimeter?
77. A man spent $\frac{3}{10}$ of his money for a house, $\frac{1}{10}$ for furniture, $\frac{1}{8}\frac{1}{2}$ for horses, and $\frac{2}{5}$ to build a church. What part of his money had he left?
78. Bought 10,752 cubic feet of wood at \$8 $\frac{1}{2}$ a cord. What did it all cost?
79. Change $\frac{\frac{2}{3} \text{ of } \frac{9}{7}}{15}$ to a simple fraction.
80. $9\frac{1}{4}$ times $\frac{1}{2}$ of $56\frac{3}{4}$ is how much?

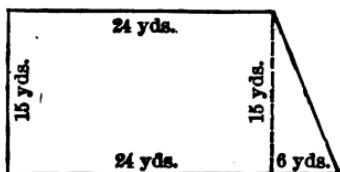
81. What is the cost of digging a cellar 27 feet square and 9 feet deep at 25¢ a cubic yard.
82. How many yards of fence will be needed to enclose the plot of ground shown in the following diagram?



83. The above field was originally a rectangle, but the owner sold one piece 5 rods by 3 rods, and a second piece 3 rods by 7 rods. How many square rods did it contain at first? What is its present area?

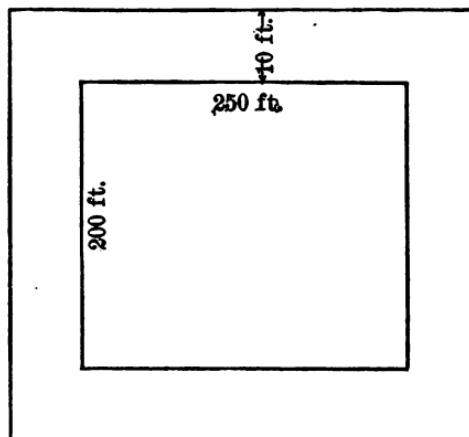
84. Calculate the number of square yards in the field shown in the accompanying diagram.

85. A man buys a piece of ground 300 feet long, 150 feet wide. He builds a house, 50 feet by 30 feet, and a shed 12 feet by 13 feet. How many square feet will he have left for a garden?



86. The owner of a piece of ground 250 feet long, 200 feet wide, takes 10 feet from each side to make a gravel walk, and uses the remainder for a garden. Give the dimensions of the garden and its area in square feet? How many square feet in the whole piece of ground? How many square feet are taken up by the walk?

87. How many square feet of flagging would be required for a sidewalk 10 feet wide outside a lot 250 feet long, 200 feet wide?



88. If a piece of carpet is 27 inches wide, and contains 48 square yards, how long is it?

89. I have bought 24 yards of dress goods, 27 inches wide. How many square yards does the piece contain?

How many yards of lining 32 inches wide will contain the same number of square yards?

24 yards long.

$\frac{4}{3}$ yd.

18 sq. yd.

? yards long.

18 sq. yd.

$\frac{4}{3}$ yd.

CHAPTER V.

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PERCENTAGE.

302. Preliminary Exercises.

Per cent means hundredths. Seven per cent means seven hundredths, $\frac{7}{100}$, or .07. It is written 7%.

How many hundredths of a number is one half of it?
 $\frac{1}{2}$ = how many hundredths? $\frac{1}{2}$? $\frac{1}{10}$? $\frac{3}{4}$? $\frac{2}{3}$?

What per cent of a number is the half of it? $\frac{1}{2}$? $\frac{1}{5}$? $\frac{1}{10}$? $\frac{1}{20}$? $\frac{1}{50}$? $\frac{1}{100}$? $\frac{1}{1000}$?

What per cent of a number is $\frac{1}{3}$ of it? $\frac{1}{3}$? $\frac{1}{6}$? $\frac{1}{12}$? $\frac{1}{20}$? $\frac{1}{30}$? $\frac{1}{100}$?

303. 1 per cent of a number is equal to what fraction of it? 3%? 5%? 9%? 10%? 15%? 20%? 25%? 30%? 40%? 50%? 60%? 75%? 90%?

304. What fractions are equal to the following?

$12\frac{1}{2}\%$? $16\frac{2}{3}\%$? $33\frac{1}{3}\%$? $37\frac{1}{2}\%$? $6\frac{1}{4}\%$? $62\frac{1}{2}\%$? $66\frac{2}{3}\%$?
 $87\frac{1}{2}\%$? $\frac{1}{2}\%$? $\frac{1}{4}\%$? $2\frac{1}{2}\%$? $\frac{1}{8}\%$?

305. 3 times a number is what per cent of it? $2\frac{1}{2}$ times?
 $1\frac{1}{2}$ times? $4\frac{1}{2}$ times?

306. Oral Exercises.

1. Find $37\frac{1}{2}\%$ of \$24.

$37\frac{1}{2}\%$ of \$24 = $\frac{3}{8}$ of \$24, or \$9. *Ans.* \$9.

2. 6% of 150 bushels.

1% of 150 bushels = 1.5 bushels = $1\frac{1}{2}$ bushels; and 6% is 6 times $1\frac{1}{2}$ bushels, or 9 bushels. *Ans.* 9 bushels.

3. 81% of 300 horses.

81% of 100 horses = 81 horses; of 300 horses it is 3 times 81 horses, or 243 horses. *Ans.* 243 horses.

In examples 2 and 3 the pupil should be led to see that he can point off two decimal places in the multiplicand instead of in the multiplier; without changing the result. The above analyses are suggestive merely. The form given in the third example is to furnish an explanation for the use of 3 as a multiplier.

4. Find $37\frac{1}{2}\%$ of 1 gallon.

$37\frac{1}{2}\%$ of 1 gal. = $\frac{3}{8}$ gal. = 3 pt. = 1 qt. 1 pt., *Ans.*

5. Find $12\frac{1}{2}\%$ of 1 gallon 15. $66\frac{2}{3}\%$ of 66 horses

6. $37\frac{1}{2}\%$ of \$24 16. $16\frac{2}{3}\%$ of 1 yard

7. $33\frac{1}{3}\%$ of 81 cows 17. 81% of \$300

8. 6% of 150 pounds 18. $2\frac{1}{2}\%$ of 80 sheep

9. 4% of 125 bushels 19. 40% of \$2.50

10. $62\frac{1}{2}\%$ of 1 peck 20. 20% of 65 rods

11. $4\frac{1}{2}\%$ of \$200 21. 10% of 15 pounds

12. 99% of 200 gallons 22. $3\frac{1}{3}\%$ of \$60

13. $\frac{1}{2}\%$ of \$640 23. $\frac{1}{8}\%$ of \$72

14. $\frac{1}{4}\%$ of 800 yards 24. $1\frac{1}{4}\%$ of \$96

The skilful teacher will appreciate the importance of rapid work, and will gradually shorten the time to be given to a class for the solution of an oral example. She will also vary her methods of conducting the recitation, so as to keep up the interest of the pupils.

TO FIND THE PERCENTAGE.

307. Written Exercises.

1. Find 6% of \$91.50.

Multiply the *base*, \$91.50, by the *rate*, 6, expressed as hundredths. The result, ~~\$5.49~~, is called the *percentage*.

$$\begin{array}{r} \$91.50 \\ \times .06 \\ \hline \$5.4900 \end{array} \quad \text{Ans.}$$

To find the percentage, multiply the base by the rate expressed as hundredths.

2. $33\frac{1}{3}\%$ of \$28.80.

While the rule is the same, to multiply \$28.80 by $.33\frac{1}{3}$, the pupil should not fail to change $33\frac{1}{3}$ hundredths to one-third.

$$\begin{array}{r} 3) \$28.80 \\ \hline \$9.60 \end{array} \quad \text{Ans.}$$

3. $\frac{1}{8}\%$ of \$1240.

$\frac{1}{8}\% = \frac{1}{800}$. Divide by 800 by cancelling the two ciphers in the divisor and making two decimal places in the dividend.

$$\begin{array}{r} 800) \$12.40 \\ \hline \$1.55 \end{array} \quad \text{Ans.}$$

4. $4\frac{1}{2}\%$ of \$92.40.

$$\$92.40 \times .04\frac{1}{2}.$$

5. 450% of \$92.40.

$$\$92.40 \times 4.5.$$

6. 12% of \$37.50

14. 860% of \$38

7. 20% of \$51.60

15. $\frac{1}{8}\%$ of \$2496

8. 1400% of \$89.70

16. 25% of \$52.36

9. $12\frac{1}{2}\%$ of \$73.28

17. 60% of \$33.30

10. $13\frac{1}{8}\%$ of \$27.60

18. 8% of \$19.50

11. $6\frac{1}{4}\%$ of \$25.60

19. $6\frac{2}{3}\%$ of \$47.40

12. $3\frac{1}{4}\%$ of \$47.40

20. 12% of \$62.50

13. $5\frac{1}{2}\%$ of \$29.50

21. $4\frac{1}{2}\%$ of \$71.50

- | | |
|---------------------|--------------------|
| 22. 40% of \$28.30 | 26. 75% of \$59.20 |
| 23. 160% of \$39.40 | 27. 87½% of \$392 |
| 24. 84% of \$23.75 | 28. 93¾% of \$496 |
| 25. 66⅔% of \$825 | 29. 15% of \$496 |

SUGGESTION.—The teacher should have a preliminary sight lesson on these examples before giving them out for written solution.

TO FIND THE BASE OR THE RATE.

308. Preliminary Exercises.

1. 40 is one-half of what number?
2. 40 is .5 of what number?
3. 40 is 50% of what number?
4. 40 is what part of 80?
5. 40 is what decimal of 80?
6. 40 is how many hundredths of 80?
7. 40 is what per cent of 80?
8. 26 is what per cent of 65?

26 is $\frac{2}{5}$ of 65. The fraction $\frac{2}{5}$ equals $\frac{4}{10}$, or 40 hundredths. *Ans.*
40 per cent.

9. 26 is 40 per cent of what number?

If 40 hundredths of a number is 26, the number equals 26 divided by 40 hundredths, or $26 \div .40$. *Ans.* 65.

To find the base, divide the percentage by the rate expressed as hundredths. To find the rate, divide the percentage by the base, expressing the result in hundredths.

Another method of finding the *base* or the *rate* is suggested in the illustrative examples on the next page, which give young pupils an introduction to the equation, a powerful instrument in mathematical investigation.

309. Written Exercises.

1. What per cent of 65 is 26?

This means, how many hundredths of 65 will equal 26? which may be expressed in the following form:

$$65 \times \frac{?}{100} = 26.$$

The *rate* being required, the foregoing may be written as follows:

$$65 \times \frac{r}{100} = 26, \text{ or } \frac{65r}{100} = 26.$$

This is called an *equation*. To solve the equation, that is, to obtain the value of r , the general method is to clear the equation of the fraction by multiplying both sides by the denominator of the fraction, 100. This gives $65r = 2600$, or 65 times r equals 2600. r , therefore, is equal to 2600 divided by 65.

Ans. 40 per cent.

PROOF. — 65×40 hundredths = 26.

2. 40 per cent of what number equals 26?

$$b \times \frac{40}{100} = 26, \text{ or } \frac{40b}{100} = 26.$$

Clearing of fractions, $40b = 2600$; $b = 65$, *Ans.*

PROOF. — 40% of 65 = $65 \times .40 = 26$.

3. 75 per cent of a number is 42. What is the number?

$$75\% = \frac{3}{4}.$$

$$b \times \frac{75}{100} = 42, \text{ or } \frac{3b}{4} = 42.$$

Clearing of fractions, $3b = 168$; $b = 56$, *Ans.*

4. What number is 15 per cent of 84?

$$p = 15 \text{ hundredths of } 84.$$

5. 24 is 18 per cent of what number?

6. 27 per cent of a number is 81. What is the number?

7. A boy spelled correctly 20 words of 25 given out. What per cent of the words did he spell correctly?

NOTE. — 25 is the base, 20 is the percentage; required the rate.

8. 132 is 120 per cent of what number?

9. $\frac{1}{5}$ per cent of a number is 23. What is the number?

10. $\frac{3}{5} =$ what per cent of $\frac{3}{4}$?

$$\frac{4}{5} \times \frac{r}{100} = \frac{3}{5}. \text{ Cancelling, } \frac{r}{125} = \frac{3}{5}.$$

Clear of fractions by multiplying both terms of the equation by 125.

Prove the correctness of your answer.

310. To clear an equation of fractions, multiply both terms of the equation by the least common denominator of the fractions.

11. $\frac{4}{5}$ is what per cent of $\frac{3}{4}$?

12. $\frac{3}{4}$ is what per cent of $\frac{4}{5}$?

$$\frac{4}{5} \times \frac{r}{100} = \frac{3}{4}; \text{ i.e. } \frac{r}{125} = \frac{3}{4}.$$

13. $3\frac{1}{3}$ is what per cent of $\frac{2}{3}$?

14. What per cent of \$ 389.50 is \$ 124.64?

15. \$ 174.04 is 95% of what sum of money?

16. $\frac{3}{4}\%$ of a number is 81. What is the number?

$$\frac{3}{4}\% \text{ of } b = 81.$$

17. 984 is $133\frac{1}{3}\%$ of what number?

18. What number increased by $33\frac{1}{3}\%$ of itself equals 984?

Let n represent the number.

$$\text{Then } n + \frac{n}{3} = 984; \text{ i.e. } \frac{4n}{3} = 984.$$

Clearing of fractions, $4n = 984 \times 3 = 2952$. $n = 738$, *Ans.*

PROOF. — $738 + 33\frac{1}{3}\%$ of 738 = $738 + 246 = 984$.

19. What number increased by 25% of itself equals 85?

311. Oral Exercises.

1. 3 is what part of 6 ?
2. 3 is what decimal of 6 ?
3. 3 is how many hundredths of 6 ?
4. 3 is what per cent of 6 ?
5. 6 is what per cent of 3 ?
6. What number is 50% of 6 ?
7. 3 is 50% of what number ?
8. 2 is what % of 100 ?
9. 2 is what % of 200 ?
10. What number is 5% of 100 ?
11. What % of 20 is 1 ?
12. 4 is what % of 200 ?
13. 3 is $\frac{1}{2}\%$ of what number ?
14. What per cent of 9 is $20\frac{1}{4}$?

$$\frac{9b}{100} = 20\frac{1}{4}; 9b = 20\frac{1}{4} \text{ hundred}; b = 2\frac{1}{4} \text{ hundred} = 225, \text{ Ans.}$$

15. What number, increased by $\frac{1}{4}$ of itself, equals 10 ?
16. What number, increased by 25% of itself, equals 20 ?
17. 65 diminished by 5% of itself equals what ?
18. Buying price \$ 100, selling price \$ 112.50. Gain % ?
19. Cost \$ 80, profit 20%. Selling price ?
20. What principal will give \$ 30 yearly interest at 6% ?
21. A man had \$ 600 in the bank. He drew out $16\frac{2}{3}$ per cent of it. How many dollars remained in the bank ?
22. A lost 40 per cent of his money, and had \$ 750 left. How much had he at first ?

23. If I am compelled to lose $12\frac{1}{2}\%$ on damaged goods, how must I sell those that cost me \$ 5.60?

24. A man put \$ 15, which was $16\frac{2}{3}\%$ of his month's salary, in the bank. What was his month's salary?

25. If each boy eats 60% of a loaf of bread, how many boys will eat 6 loaves?

NOTE. — In the solution of the foregoing oral problems, pupils should not be compelled to use the method suggested for the written exercises.

REVIEW.

312. Written Problems.

1. A man receives from a bank 4% a year as interest on money he has in the bank. If his interest for a year is \$ 60, how much money has he in the bank?

2. A city had a population of 4500 at the end of 1903. The population at the end of 1904 was 1080 greater. What per cent did the population increase during the year?

$$1080 = \text{what per cent of } 4500?$$

3. A person who sold an article for 25% more than its cost, received \$ 85 for it. What was the cost?

$$\text{Cost} + \frac{1}{4} \text{cost} = \$85.$$

4. A person receives \$ 45 annual interest on \$ 1000. What rate per cent does he receive?

5. A farmer sold $16\frac{2}{3}$ per cent of his sheep, and had 75 remaining. How many had he at first?

6. A clerk has an income of \$ 1100 per annum. He pays 20 per cent of it for board, $1\frac{1}{2}$ per cent for washing, 2 per cent for incidentals, 15 per cent for clothing, 9 per cent for other expenses, and loses in various ways 50 per cent of the amount then remaining. What sum does he have left?

7. What per cent of a school is boys, and what per cent girls, there being 640 of the former and 560 of the latter?
8. What per cent of 9.075 is 24.2?
9. How large a sale must a merchant make, at a profit of 15%, that his gain may be \$3750?
10. A coal dealer bought 25,784 tons of coal at \$5 a ton. He sold 40% of it at \$7, 20% of it at \$8.50, and the remainder at \$4.50. How much did he gain?
11. A man shipped 600 barrels of flour, and lost 16 $\frac{2}{3}$ % of it by storm; he sold 75% of the remainder. What per cent of the whole remained?
12. 66 $\frac{2}{3}$ % of 200 bushels is 2 $\frac{1}{2}$ % of how many bushels?
13. If corn selling for 21 $\frac{1}{2}$ a bushel more than cost gives a profit of 30%, what did it cost?
14. $\frac{1}{2} + \frac{1}{6}$ of a number is what per cent of it?
15. A boy deposited \$15 in bank. This was 30 per cent of what he had in bank before making this deposit. What had he there after this deposit?
16. A man can do a certain work in 18 $\frac{1}{2}$ days. What per cent of it can he do in 6 $\frac{1}{2}$ days?
17. A man spent 30 per cent of his money for clothes, 20 per cent for rent, and had \$75 left. What rent did he pay?
18. What is the difference between $\frac{1}{2}$ per cent of \$15,000 and 50 per cent of \$15,000?
19. A pole extended into the mud 5 $\frac{1}{2}$ feet; 33 $\frac{1}{3}$ % of its length was in the river and 25% of it in the air. What was the length of the pole?
20. There were 984 patients in a certain hospital, classified as follows: 369, pulmonary diseases; 246, nervous diseases; 123, diseases of heart; and 246, various other diseases. Give the per cent of each class.

APPLICATIONS OF PERCENTAGE.

313. Commission.—The term *per cent* occurs in many business transactions. A person who sells goods for another receives a certain per cent of the amount he obtains for the goods, as a *commission*. A person who buys goods for another is paid a *commission*, which is a certain per cent of the cost of the goods. A person who collects money for another is paid a *commission* of a certain per cent of the amount collected.

Commission is a percentage paid to an agent for his services.

314. Insurance.—The owner of property who desires to be insured for a definite sum pays some per cent of this sum for the insurance. The amount he pays is called the *premium*. The document given by the insurance company as a receipt is called a *policy*. It states the agreement of the company to pay the owner of the property a sum equivalent to the loss sustained, provided that it does not exceed the sum for which the owner is insured. Thus, the owner of a house valued at \$5000 may insure it against fire for \$4000. If the house is injured to the extent of \$4000 or less, the owner receives from the company the amount of the loss.

Insurance is a contract by which one party agrees to pay to another a specified sum in case of loss or damage.

NOTE.—The teacher should show pupils an insurance policy, and read the contract made by the company as expressed therein.

315. Duties.—The United States government collects from the importers of certain classes of goods a stated percentage of the value of the goods. This charge is called a *duty*.

Duties are taxes on imported goods.

NOTE.—Some duties are based upon a certain rate per square yard, per pound, etc.

316. Taxes.—For the expenses of maintaining a city, property owners pay a certain percentage of the valuation of their property as determined by the proper officials. The money thus collected from the owner is called a *tax*. The value fixed by the authorities is called the *assessed value*, which is generally somewhat less than the actual value.

A tax is a sum of money levied on persons or property for public purposes.

NOTE.—In many places the tax rate is fixed at so many thousandths of the assessed value.

The following ten oral and twenty written problems involve no new principles. The general formula $b \times \frac{r}{100} = p$ is applicable to each of them. The accompanying statement shows the *base* on which the percentage is calculated in certain classes of examples; also the name given to the *percentage*.

	<i>Base</i>	<i>Percentage</i>
COMMISSION . . .	Value of goods bought or sold, etc.	Commission Brokerage
INSURANCE . . .	Sum for which property is insured	Premium
TAXES	Assessed value of prop- erty	Taxes
DUTIES	Value of goods imported	Duty

317. Oral Problems.

1. An agent collected a bill, and sent to his employer the amount, less $2\frac{1}{2}\%$ commission. If his commission was \$1.60, how much did he remit to his employer?
2. My house, worth \$12,000, is insured for $\frac{3}{4}$ of its value, at $\frac{1}{4}\%$. What premium do I pay?

3. A man collected a bill of \$300 for me, at $\frac{1}{2}\%$ commission. How much was his commission?
4. Mr. Eastman collects bills for me, and I pay him $12\frac{1}{2}\%$. He pays over to me \$56. How much did he collect?
5. What is the premium for insuring \$3600 on my house at $\frac{1}{4}\%$?
6. What will it cost to insure a house worth \$5000, at $\frac{1}{2}\%$ premium?
7. Find the duty at 35% on goods valued at \$2000.
8. My taxes for 1904 are \$175. The rate is $1\frac{1}{4}\%$ per cent. What is the assessed value of my property?
9. My agent collects the yearly rent of my house, and retains \$15, the amount of his commission at $2\frac{1}{2}\%$ per cent. For how much does the house rent per year?

318. Written Problems.

1. How much insurance does a man receive for \$12.50 when the rate is $2\frac{1}{2}\%$?
2. An importer paid duties amounting to \$386.75. If the duty was 25% of the cost of the goods, what was their cost?
3. A collector deducts $2\frac{1}{2}\%$ commission, and returns to his employer \$745.68. How much did he collect?

Let x represent the sum collected. Then $2\frac{1}{2}\%$ of x , or $\frac{x}{40}$, will represent the commission; and $x - \frac{x}{40}$, or $\frac{39x}{40}$, will represent the amount returned to the employer.

$$\frac{39x}{40} = 745.68.$$

Clearing of fractions : $39x = 29,827.20$.

$$x = 764.80. \text{ Ans. } \$764.80.$$

It will be noted that only abstract numbers are used in an equation, the denomination being supplied in the answer.

4. The tax rate of a certain city is $1\frac{1}{4}\%$ upon the assessed value of property. If this value is 75% of the actual value, how much taxes does Mr. Smith pay upon a house and lot, the actual value of which is \$ 24,000?

5. The tax on an assessment of \$ 8500 is \$ 48.45. Required the rate on \$ 1000 of assessment.

6. Find the amount of an agent's sales, when his commission at 5 per cent amounts to \$ 37.65.

7. An agent buying wheat is offered a commission of $4\frac{1}{2}\%$ per bushel, or one of $4\frac{1}{2}\%$ per cent, and he chooses the former. The average price paid per bushel is $91\frac{1}{2}\text{¢}$. Does he gain or lose by his choice, and how much per bushel?

8. A commission of \$ 121.29 was charged for selling \$ 1866 worth of goods. What was the rate of commission?

9. A man insured his house for \$ 6500, his store for \$ 3500, and his goods for \$ 7000, at $\frac{1}{2}\%$. What did his insurance come to?

10. If a piece of property is taxed \$ 28.60, at a tax rate of $\frac{1}{2}$ of one per cent, what is the assessed value of the property?

11. A house valued at \$ 24,000 was insured for two-thirds of its value, at $\frac{3}{4}\%$. What is the premium?

12. An agent collected 20% of an account of \$ 750, charging 4% commission. What was his commission, and what sum should he have paid over?

13. Paid \$ 27 for an insurance policy on my house. If the rate is $\frac{3}{4}\%$, for how much is my house insured?

14. My agent collected 80 per cent of a debt of \$ 4500, and charged $7\frac{1}{2}$ per cent commission. What amount should he pay me?

15. A farmer bought 6 cows through an agent. He sent \$525.30 to pay for the cows and a commission of 3%. How much did each cow cost?

16. What will be a broker's commission, at $2\frac{1}{2}\%$, for selling a farm of 673 acres @ \$52 per acre?

17. If the tax rate is \$13.80 on \$1000, what is the assessed value of property that pays a tax of \$144.90?

18. A house is insured for $\frac{2}{3}$ of its value at $\frac{1}{4}\%$. The annual cost (premium) is \$8.40. What is the value of the house?

Let x represent the value. Then $\frac{2}{3}x \times \frac{7}{800}$, or $\frac{7x}{1200}$, will represent the premium.

$$\text{The equation becomes } \frac{7x}{1200} = 8.40.$$

19. What will be the taxes on a house worth \$48,000 and assessed at $\frac{2}{3}$ of its value, the tax rate being \$18.50 per \$1000 of assessed value?

20. A commission merchant receives $2\frac{1}{2}\%$ commission for buying grain for a customer. The cost of the grain and his commission amount to \$4223. How much does the grain cost?

Let x represent the cost of the grain; $\frac{x}{40}$ will be the commission.

21. An importer paid \$134.40 duties on imported goods valued at \$384. Find the rate.

22. What is the duty in United States money on glass ware valued at 1500 francs, the rate being 60%, and the franc being worth 19.3 cents?

23. Find the duty on a gross of scissors, valued at \$2.50 per dozen, the rate being 75 cents per dozen and 25% on the value.

PROFIT AND LOSS.

In determining the rate per cent of gain or loss on goods sold, the buying price of the goods is taken as the base.

319. Oral Problems.

1. What is the gain per cent on sugar bought at 5 cents per pound and sold at 6 cents per pound?

Profit 1¢, which is one-fifth of buying price, or 20%.

2. By selling a house for \$3500, I lose \$500. What is my loss per cent?

The loss, \$500, is what per cent of the cost, \$4000?

3. By selling a lot for \$1000, Mr. Jones loses 20 per cent. What did the lot cost?

The selling price, \$1000, is four-fifths of the cost.

4. Find the cost of an article which was sold for \$60, at a loss of 70%.

5. If I buy a dozen pencils at 2¢ each, and sell at 3¢ each, what is the gain per cent?

6. A saddle was sold for \$18, which was $12\frac{1}{2}\%$ more than the cost. How much did it cost?

7. What % is gained on goods sold at double the cost?

8. Sold flour at a profit of \$2, and gained 25%. What was the cost per barrel?

9. What is the % of gain, when boots which cost \$2 a pair are sold for \$2.50?

10. What per cent is lost in buying potatoes at 80¢ a bushel, and selling them at 60¢ a bushel?

11. If I buy butter at 30¢ a pound, how much per cent do I gain by selling it at 36¢ a pound?

320. Written Exercises.

Find the profit or the loss, and the selling price:

1. Cost \$1876; gain 15%.

$\text{Gain} = 15 \text{ per cent of } \$1876.$ Selling price = cost + gain.

2. Cost \$36.75; loss 20%.
3. Cost \$1012.50; gain $16\frac{2}{3}\%$.
4. Cost \$875; loss 5%.
5. Cost \$934.56; gain $12\frac{1}{2}\%$.

Find the profit or the loss per cent.

6. Cost \$600; selling price \$618.

$$\$18 = ? \% \text{ of } \$600.$$

7. Cost \$1203; selling price \$802.
8. Cost \$86.20; selling price \$73.27.
9. Cost \$908.40; selling price \$1090.08.
10. Cost \$84; selling price \$78.75.
11. Selling price \$78.75; loss \$5.25.

NOTE.—Cost = \$78.75 + \$5.25 = \$84.

12. Selling price \$150; gain \$25.

Use the cost ($\$150 - \25) as the base.

13. Selling price \$831.25; loss \$43.75.
14. Selling price \$1051.38; gain \$116.82.
15. Selling price \$843.75; loss \$168.75.

Find the cost, and the profit or loss:

16. Selling price \$468.75; gain 25%.

Representing the cost by x , the selling price is $\frac{5x}{4}$.

$$\frac{5x}{4} = 468.75.$$

17. Selling price \$73.84; loss 20%.
18. Selling price \$1646.08; gain $33\frac{1}{3}\%$.
19. Selling price \$204; loss 15%.
20. Selling price \$66.30; gain 4%.
21. A man buys a horse for \$275, and sells it at a profit of 20 per cent. How much does he gain?
22. A cow is sold for \$75, on which the profit is \$15. What is the gain per cent?
23. A lot is sold for \$960, which is 20 per cent more than it cost. Find the cost of the lot.
24. Tea that costs 32¢ per pound is sold for 48¢. What is the gain per cent?
25. A man buys a horse for \$175 and sells it for \$200. What per cent does he gain?
26. What per cent was lost on a horse that cost \$200, and that was sold at a loss of \$25?
27. What is the selling price of dress goods costing $33\frac{1}{3}\%$ per yard, on which a profit of $12\frac{1}{2}\%$ per cent is made?
28. Sold a coat for \$33.60, thereby losing 16 per cent. What was its cost?
29. How much did I gain on a house for which I paid \$8760, my profit being $2\frac{1}{2}\%$ per cent?
30. A man paid for a house \$4500, and for repairs \$150, and then sold it for 18% above the entire cost. What did he receive for it?
31. To make 15 per cent profit, what must goods be marked that cost 96 cents per yard?
32. Goods costing 96 cents per yard are marked at 25% advance, what per cent is gained if they are sold 10% below the marked price?
33. Find the per cent of profit on apples bought at \$1.25 per bushel, and sold at 25 cents per half peck.

COMMERCIAL DISCOUNT.

321. Wholesale dealers in certain classes of goods allow to purchasers of large quantities a deduction from the prices printed in their catalogues. This is called a *trade discount* or *commercial discount*. A discount for prompt payment is also frequently allowed. The following bill contains a trade discount and a discount for cash:

PHILADELPHIA, Jan. 17, 1904.

THE OCEAN BATHING SUIT CO.

Terms: Cash less 5 per cent.

Sold to Mr. J. H. HAAREN.

<i>12$\frac{6}{13}$ doz. Suits</i>	<i>\$18</i>	<i>\$225</i>	<i>—</i>	
	<i>less 15%</i>	<i>33</i>	<i>75</i>	
		<i><u>\$191</u></i>	<i>25</i>	
	<i>Cash less 5%</i>		<i>9</i>	<i>56</i>
				<i>\$181 69</i>

1. Make out a bill for 16 gross of roman candles at \$26.75 per gross, less 60%.
 2. On a bill of goods amounting to \$ 583.40, a discount of 5% is given for cash. What is the amount paid?
 3. Sept. 1, 1905, Mr. Maxwell bought tea amounting to \$1876.50. If 5% is deducted for payment within ten days, how much should he pay if he paid the bill Sept. 9?
 4. What will be the cost of 15 cases cocoa @ \$13.20 each, less 20%?

5. Bought 5 gross of essence of lemon at 50¢ per doz., less 5%. What is the amount of my bill?

6. Find the cost of 15 cases of chloride of lime, 50 lb. per case, at 9½¢ per pound, less 15%.

7. Find the cost of a wagon, the catalogue price of which is \$750, the discount being 30%.

8. What will be the cost of goods amounting to \$1837.60, on which there is allowed a discount of 17½%?

9. Find the net cost of 1630 yd. silk, invoiced at \$1.10 per yard, less 16% discount.

NOTE. — The amount previous to the deduction of the discount is known as the *gross* amount. The *net* amount or the net cost is the sum actually due after the deduction of the discount.

10. What is the cost, in francs, of 843.72 meters silk, at 5.75 francs per meter, less 12%?

11. What will be the net cost of a bill of plated ware amounting to \$84.75, on which a discount of 33½ and 10% is allowed?

\$ 84.75	
less $\frac{1}{3}$	$\frac{28.25}{56.50}$
less $\frac{1}{10}$	$\frac{5.65}{}$
<i>Ans.</i> \$	net.

When more than one discount is given, each successive discount is based on the remainder left after the deduction of the previous discount.

NOTE. — The mark % is generally written only after the last rate.

12. Find the difference between \$390 less 43½% discount, and \$390 less 33½ and 10% discount.

13. An army fought two battles. In the first it lost 15 per cent, and in the second 20 per cent of the original number, after which it mustered 19,500 men. What was the original strength of the army?

14. Find the net cost of 18,500 bags at \$ 4.40 per M, less 60 and 10 and 5%.

15. What is the net cost of a lot of musical instruments amounting to \$ 1875.60, on which a discount of 10, 5, and $2\frac{1}{2}\%$ is allowed?

16. What would be the net cost of the same articles, if the discount were $2\frac{1}{2}$, 5, and 10%?

17. Find the net cost of the same, at $17\frac{1}{2}\%$ discount.

18. Which is the better discount for the buyer, 40 and 10% or 30 and 20? What will be the difference on a bill of \$ 100?

19. \$ 100 less $33\frac{1}{3}$ and 10% discount is equal to what? What per cent discount is $33\frac{1}{3}$ and 10% equal to?

20. \$ 100 less 10 and $33\frac{1}{3}\%$ is equal to what?

NOTE.—The pupil will note that the result is the same as in Problem 19.

21. A man marks an article \$ 1.50, and sells it at a discount of 25% from the marked price. If the article cost him 90¢, what is his gain per cent?

22. John Jasper & Co. sold the following goods. Make out the bill, less 50 and 10 and 10 and 10% discount.

500	$\frac{1}{4}$ -pound bags	at \$ 1.00 per M.
1500	$\frac{1}{2}$ -pound bags	at 1.20 per M.
3000	1-pound bags	at 1.60 per M.
5500	$1\frac{1}{2}$ -pound bags	at 1.70 per M.
2000	2-pound bags	at 2.00 per M.

NOTE.—In making out large numbers of bills clerks have no time for unnecessary words. The first item would be written as follows:

500	$\frac{1}{4}$ lb. Bags	\$ 1.	.50
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the words "at" and "per M" being considered unnecessary.

322. Oral Problems.

1. A piano, marked \$ 800, is sold at a discount of 25 and 10%. What is the selling price?

2. Bought goods amounting to \$ 600, less 5% for cash. What is the net cost of the goods?

3. What single discount is 50 and 10% equal to?

Taking \$ 100 as a base, 50 % discount deducts \$ 50 and leaves \$ 50. 10 % deducts \$ 5, leaving \$ 45. The total deduction is \$ 55; the single equivalent discount is 55%.

4. What single discount is 30 and 30% equal to?

Representing the base by x , the first discount is 30 % of x , or $\frac{30x}{100}$, leaving $\frac{70x}{100}$. The second discount is $\frac{1}{10}$ of $\frac{70x}{100}$, which is $\frac{21x}{100}$. The two discounts are $\frac{30x}{100}$ and $\frac{21x}{100}$, which make a total of $\frac{51x}{100}$, or 51 % of the base.

5. Paid \$ 729 for goods, on which 10% was allowed. What was the "gross" price?

6. How much will be paid for 12 doz. bottles flavoring extract, at 60¢ per dozen, less 10%?

7. What is the "list" price of an article for which I paid \$ 48, after a discount of 25% was deducted?

Note. — The "list" price, "gross" price, or "catalogue" price is the price before the deduction of discounts.

8. What is the net price of an article catalogued at \$ 880, on which there is a discount of 75%?

Note. — A discount of 75 % from the list price means that the net price is 25 % of the list price. Instead, therefore, of finding 75 % of \$ 880 and deducting it from \$ 880, the pupil should shorten the work by taking 25% of \$ 880.

9. 75 is 25% more than what number?

10. Find the cost of a wagon "catalogued" at \$ 700, the discount being 30%.

Note. — The cost is 70 % of \$ 700.

INTEREST.

323. Preliminary Exercises.

1. A farmer, needing \$1000 to purchase additional land, borrows the money, agreeing to repay it at a given time with 6% of the sum for each year he has the use of it. This annual payment of \$60 for the use of \$1000 is called *interest*. The \$1000 is called the *principal*. If the borrower repays the \$1000 at the end of two years and also \$120 interest, the total payment of \$1120 is called the *amount*.
2. What is the interest on \$1000 at 6% for 6 months?
3. What is the amount of \$1000 for 3 years at 6%?
4. What is the interest on \$1000 for 1 month at 6%?
5. Taking 30 days to a month, find the interest on \$1000 for 15 days at 6%.

324. Written Exercises.

1. Find the interest on \$750 at 6% for 2 years 6 months.

The interest for 1 year is found by multiplying the principal, \$750, by the rate, 6 hundredths, and this product by the number of years,
 $2\frac{1}{2}$.

$$\begin{array}{r}
 \$750 \text{ Principal.} \\
 \times .06 \text{ Rate.} \\
 \hline
 \text{Interest for 1 yr. } \$45.00 \\
 \times 2\frac{1}{2} \text{ Time.} \\
 \hline
 \$90. \\
 22.50 \\
 \hline
 \text{Interest for 2 yr. 6 mo. } \$112.50
 \end{array}$$

The foregoing may be expressed by the formula :

$$\text{Principal} \times \frac{\text{Rate}}{100} \times \text{Time (in years)} = \text{Interest}$$

It is suggested that the work be arranged in this manner, so that it may be shortened by cancellation.

$$\begin{array}{r}
 \$15 \quad 3 \\
 \$750 \times \frac{6}{100} \times \frac{5}{2} = \frac{\$225}{2} = \$112.50, \text{ Ans.} \\
 2
 \end{array}$$

2. What is the interest on \$84.75 at 4% for 3 months 6 days? 3 months 6 days = $\frac{96}{360}$ year.

The 100 in the divisor is cancelled by removing the decimal point in the principal two places to the left.

$$\begin{array}{r} .0565 \\ \$84.75 \times \frac{4}{100} \times \frac{96}{360} \\ \hline \end{array} \quad \begin{array}{l} 16 \\ \$84.75 \times \frac{4}{100} \times \frac{96}{360} \\ \hline 96 \\ 96 \\ \hline 0 \end{array}$$

Ans. 90 cents.

3. Find the interest on \$394.50 for 2 years 7 months 24 days at $4\frac{1}{2}\%$.

$$\begin{array}{r} .477 \\ \$394.50 \times \frac{9}{200} \times \frac{954}{360} \\ \hline \end{array} \quad \begin{array}{l} \$188.1765 \\ \hline 4 \\ \$188.1765 \\ \hline 4 \\ \$47.0415 \end{array}$$

Ans. \$47.04.

The time is readily changed to days: $720 + 210 + 24 = 954$.

This is expressed in years by placing 360 in the divisor, i.e. below the line. The three ciphers in the divisor are cancelled by moving the decimal point in the principal three places to the left.

In calculating interest, take 30 days to a month, 12 months to a year.

Find the interest on

4. \$308 at 5% for 20 days. 6. \$720 at 7% for 21 days.
 5. \$360 at 5% for 33 days. 7. \$1000 at 5% for 8 days.
 8. \$94.43 at 7% for 2 mo. 3 da.
 9. \$464.75 at 6% for 8 mo. 12 da.
 10. \$400 at $4\frac{1}{2}\%$ for 1 yr. 1 mo. 1 da.

325. *Amount = Principal + Interest.*

Find the amount:

1. \$813, from April 19, 1902, to March 4, 1907, at 6%.

The time is found by compound subtraction.

1907	3	4
4 yr. 10 mo. 15 da.		
1902	4	19

 $\begin{array}{r} .271 \\ \hline 4 & 10 & 15 \\ \hline 4 & 10 & 15 \end{array}$

$$\begin{array}{r} .271 \\ \hline \text{Interest} = \$813 \times \frac{9}{100} \times \frac{1755}{360} = \$237.80 + \\ \hline \end{array} \quad \begin{array}{l} \$237.80 \\ + \\ \$2 \\ \hline \$237.80 \end{array}$$

$$\text{Amount} = \$813 + \$237.80 = \$1050.80, \text{ Ans.}$$

2. \$ 960, from Jan. 1, 1903, to Dec. 21, 1904, at 4%.
3. \$ 27.84, for 3 yr. 6 mo. 9 da., at 6%.
4. \$ 48.90, for 17 da., at 6%.
5. \$ 144, for 2 yr. 5 da., at $3\frac{3}{4}\%$.
6. \$ 834.76, for 15 mo. 27 da., at $4\frac{1}{2}\%$.
7. \$ 5760, for 1 yr. 5 mo. 29 da., at 5%.
8. \$ 2346.50, for 7 yr. 13 da., at 3%.
9. \$ 1892, for 3 yr. 5 mo., at 7%.
10. \$ 150.40, for 1 yr. 2 mo. 3 da., at 6%.

326. Interest-bearing Demand Notes.

A promissory note is a written agreement to pay a stated sum of money after a given time or on demand to a certain person with or without interest. The person signing the note below, James Dunne, is called the *maker*; the person in whose favor it is drawn, Charles C. Wise, the *payee*. If the latter wishes to transfer it to James H. Tully, he writes on the back of the note: Pay to the order of James H. Tully; and underneath he signs his name. This is called an *indorsement in full*. By merely signing his name on the back, which is called an *indorsement in blank*, Mr. Wise makes it payable to any person holding it. The effect of an indorsement is also to make the indorser liable in the event of the maker refusing to pay.

1.

SAN FRANCISCO, Jan. 7, 1902.

On demand, I promise to pay Charles C. Wise, or order, Seven Hundred Sixty-five $\frac{4}{100}$ Dollars, value received, with interest at 6 per cent.

\$ 765 $\frac{4}{100}$.

JAMES DUNNE.

How much money will be required to pay the above note, with interest, July 15, 1903?

2. A demand note, dated Sept. 25, 1902, with interest at 8% from date, is paid Jan. 2, 1905. How much was due, the face of the note being \$750?
3. Find the amount due March 4, 1904, on a note for \$365.84, dated May 20, 1902, with interest from date at 7%.
4. Find the amount necessary, Oct. 16, 1906, to pay a note of \$1240, with interest at 6% from Aug. 15, 1902.
5. An interest-bearing note for \$87.60 is dated April 3, 1900. How much is due on it for principal and interest Jan. 2, 1908? Rate $4\frac{1}{2}\%$.

327. Oral Problems.

If these are first used as sight problems, an opportunity will be afforded to develop different methods for solving many of them.

1. Find the interest on \$300, for 1 yr. 7 mo., at 4%.
\$12 per year is how much for 7 months?
2. On \$60, for 33 days, at 6%.
\$3.60 for 360 days is how much for 33 days?
3. On \$120, from Jan. 1, 1903, to July 1, 1904, at 5%.
4. How long will it take \$100 to produce \$15, interest at 6%?
5. At what rate per cent will \$50 produce \$6 in 2 years?
6. What is the interest on \$300, at 6%, from Feb. 1 to Feb. 21?
7. What part of a year is 72 days?
8. Find the interest at 4%, for 90 days, on \$150.
9. On \$240, for 36 days, at 5%.
10. What is the amount of \$200, for 3 yr. 1 mo., at 6%?
11. How long will it take \$1 to make \$1 interest at 5%?
12. How long will it take any sum to double itself at 6%?
13. How long will it take \$14.90 to double itself at 4%?

PARTIAL PAYMENTS.**328. United States Rule.**

When the maker of an interest-bearing note pays a portion of the debt represented by the note, the money is applied in the first place to the payment of the interest, then to the reduction of the principal.

1. DULUTH, MINN., Jan. 5, 1902.

On demand, I promise to pay to the order of James F. McGee Three Hundred Dollars, value received, with interest at 7 per cent.

\$300₁₀₀. J. RANDOLPH PAGE.

Payments: May 20, 1902, \$100; Oct. 30, 1902, \$100; March 6, 1903, \$50.

How much was due Jan. 5, 1904?

Find amount of \$300 Jan. 5, 1902, to first payment May 20, 1902,
4 mo. 15 da. (by compound subtraction), \$ 307.88

Deduct first payment, 100.00

Balance May 20, 1902, \$ 207.88

Interest on \$ 207.88 to Oct. 30, 5 mo. 10 da., 6.47

Amount, \$ 214.35

Less second payment, 100.00

Balance Oct. 30, 1902, \$ 114.35

Interest on \$ 114.35 Oct. 30 to March 6, 4 mo. 6 da., 2.80

Amount, \$ 117.15

Less third payment, 50.00

Balance March 6, 1903, \$ 67.15

Interest on \$ 67.15 March 6 to Jan. 5, 9 mo. 29 da., 3.90

Due Jan. 5, 1904, \$ 71.05

Find the amount of the principal to the time when the payment or the sum of two or more payments equals or exceeds the interest.

From this amount deduct the payment or sum of payments.

Use the balance then due as a new principal, and proceed as before.

2. How much is due June 3, 1905, on a demand note for \$1200, with interest at 6 %, dated June 3, 1902, bearing indorsements of payment of \$500, Sept. 18, 1903; \$600, Jan. 3, 1904?

NOTE. — Anything written on the back of a document is called an *indorsement*. Payments made are usually written on the back of the notes.

3. A demand note for \$600, bearing interest at 5 %, was given Feb. 18, 1902. A payment of \$250 was made May 28, 1903; one of \$150 was made Oct. 8, 1903. How much is due Jan. 23, 1905?

4. A note for \$2000, with interest at 7 %, was dated April 15, 1901. Indorsements were made as follows: \$50, Sept. 20, 1901; \$100, May 26, 1902; \$1000, June 20, 1903. How much is due Dec. 27, 1904?

Face of note,	\$ 2000.00
Interest from April 15 to Sept. 20, 1901, 5 mo. 5 da.,	<u>60.28</u>
Amount due Sept. 20, 1901,	\$ 2060.28

If the \$50 payment were deducted, and interest computed on the balance, \$2010.27, the maker would be charged interest on \$10.27 more than the face of the note, and this the law does not allow. Interest is taken on \$2000 until next payment, May 26, 1902, 8 mo. 6 da.,

Amount due May 26, 1902,	\$ 95.67
	\$ 2155.95

As the two payments are not large enough to meet the interest now due, the interest is again computed on the original \$2000 from May 26, 1902, to June 20, 1903, 1 yr.

24 da.,	149.33
	\$ 2305.28

Amount of \$2000 from April 15, 1901 to June 20, 1903,	\$ 2305.28
Less \$50 + \$100 + \$1000 (three payments),	<u>1150.00</u>

Balance due June 20, 1903,	\$ 1155.28
Interest on \$1155.28 to Dec. 27, 1904, 1 yr. 6 mo. 7 da.,	<u>122.87</u>

Due Dec. 27, 1904,	\$ 1278.15
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5. ALBANY, N.Y., March 5, 1903.

One year after date, I promise to pay John Harrigan, or order, Nine Hundred Dollars, value received, with interest at six per cent.

$\$900\frac{9}{100}$.

ANDREW T. SULLIVAN.

Indorsed as follows: June 5, 1903, \$10; Sept. 5, 1903, \$50; Jan. 5, 1904, \$120. What was due March 8, 1904?

6. ALEXANDRIA, LA., June 19, 1903.

On demand I promise to pay to the order of George H. Dotzert, Two Thousand Four Hundred Fifty-four $\frac{75}{100}$ Dollars, value received, with interest at 6 per cent.

$\$2454\frac{75}{100}$.

CHARLES W. LYON.

The following payments were made: July 5, 1903, \$450; Sept. 18, 1903, \$700; Oct. 25, 1903, \$300. Find the amount due Jan. 2, 1904.

329. In the United States courts, and in those of some of the states, interest for a portion of a year is taken by days, upon the basis of 365 days to the year. To make the work easier for the pupils, however, the year of 360 days should be used in the examples given, and the time between dates should be found by compound subtraction.

330. Merchants' Rule.

The merchants' rule is frequently used where all the payments are made within a year.

The interest is computed on the face of an interest-bearing note from its date until settlement, and interest is allowed on all credits from their payment until settlement.

The exact number of days is taken, and the interest is computed on the basis of 360 days to the year.

BOSTON, MASS., June 19, 1903.

On demand, I promise to pay Charles R. Buttrick, or order, Two Thousand Four Hundred Fifty-four $\frac{75}{100}$ Dollars, value received, with interest at 6 per cent.

$\$2454\frac{75}{100}$.

JOHN J. P. FAGAN.

The following payments are endorsed on the note: July 5, 1903, \$200; July 29, 1903, \$450; Sept. 18, 1903, \$700; Oct. 25, 1903, \$300.

Find the amount due Jan. 2, 1904.

If no payments had been made, there would be due,	\$ 2454.75
And interest from June 19 to Jan. 2, 197 days,	80.60
Total due,	<u>\$ 2535.35</u>
The credits are: Payment July 5, 1903,	\$ 200.00
Interest on \$200, July 5 to Jan. 2, 181 days,	6.08
Payment July 29, 1903,	450.00
Interest on \$450, July 29 to Jan. 2, 157 days,	11.78
Payment Sept. 18, 1903,	700.00
Interest on \$700, Sept. 18 to Jan. 2, 106 days,	12.37
Payment Oct. 25, 1903,	300.00
Interest on \$300, Oct. 25 to Jan. 2, 69 days.	<u>3.45</u>
Balance due,	<u><u>\$ 1683.63</u></u>
	<u><u>\$ 851.72</u></u>

Find the amount of an interest-bearing note at the time of settlement.

Find the amount of each credit from its time of payment to the time of settlement; subtract their sum from the amount of the note.

331. Written Exercises.

1. A note for \$500, with interest at 6 %, is dated July 25, 1904. Payments are made: \$100, Sept. 18; \$200, Feb. 5, 1905. How much is due April 1, 1905?
2. Find amount due Sept. 15, 1903, on a demand note for \$1875, with interest at 6 %, dated Jan. 18, 1903. Payments of \$1000 and \$500 were made March 30 and June 17, respectively.
3. June 12, 1904, Robert Colgate bought goods amounting to \$600. Dec. 31, 1904, he paid \$300; April 5, 1905, \$200; June 1, 1905, he settled the account. How much did he pay on that date, if he is charged 6 % on the purchase from its date, and is allowed 6 % interest on his payments?

4. John C. Kelley loaned Chas. R. Robertson \$500, Sept. 1, at 6 %. Payments of \$200 each were made Oct. 1 and Nov. 1. How much is due Dec. 1 ?

<i>Dr.</i>	HORACE E. DRESSER						<i>Cr.</i>
1905. Feb. 5	To merchandise, To interest to date,	840	00	1905. Mar. 9 Sept. 13 Dec. 31 “ “	By cash, By cash, By interest to date, By cash,	500 00 200 00 —	
Dec. 31							

5. Find the amount paid in settlement of the foregoing account, Dec. 31, 1905. Interest 6 %.

6. A merchant's books show the following debits : Feb. 13, merchandise, \$725.00; April 14, merchandise, \$603.00. The credits are: April 5, cash, \$600; Aug. 29, cash, \$300. How much is due Oct. 5, interest 6 %?

332. Oral Exercises.

- If I sell for \$4.50 a book which cost me \$3, what per cent do I gain ?
- What is the interest of \$200, for 90 days, at 3 % ?
- One acre of corn yields 80 bushels, and another acre 20 % more. What does the second acre yield ?
- What will it cost to fence a garden 10 rods long and 6 rods wide, at \$1 a rod ?
- In a certain school 40 pupils are present and 10 are absent. What per cent are absent ?
- What is the difference between a floor 40 feet square and two others each 20 feet square ?

7. What is the interest of \$12, for 1 yr. 4 mo., at 6%?
8. If $2\frac{1}{2}$ pecks of berries cost one dollar, what would 3 quarts cost at the same rate?
9. Bought 5 bushels nuts at a dollar a peck, and got 5% off for cash. How much did I pay for the nuts?

333. Written Problems.

1. Gold coin contains 90 per cent gold, 9 per cent silver, 1 per cent copper. Find the quantity of each metal in 50 double-eagles (\$20), each containing 516 grains.
2. A, B, and C buy a farm. A pays \$8700, B pays \$7200, C pays \$4100. What per cent of the purchase money does each furnish?
3. The one-cent pieces weigh 48 grains. How many dollars would weigh 120 pounds avoirdupois (7000 grains to pound)?
4. If a person lends me \$250 for 8 months, for how long ought I to lend him \$400 as an equivalent?
5. Goods costing \$8 are sold at an advance of 20 per cent. The marked price is \$12. What per cent reduction is made on the marked price?
6. There are 5 boys whose heights are 4 ft. 9 in., 5 ft. 1 in., 4 ft. 5 in., 3 ft. 11 in., and 4 ft. 4 in., respectively. What is their average height?
7. In the written number 185.4, the number expressed by the first two (left-hand) figures is how many time the value expressed by the second two figures?
8. Express decimaly, and also as a common fraction, the value of each of the following: 115 per cent; $\frac{1}{16}$ of 1 per cent; $\frac{1}{8}\frac{1}{2}$ of 1 per cent.
9. M bought $\frac{5}{7}$ of a manufacturing business for \$3517.85, and N bought $\frac{4}{9}$ of the same business at the same rate. How much did N's interest cost him?

334. To find Principal, Rate, or Time.

1. What principal will produce \$2.88 interest in 8 months at $4\frac{1}{2}\%$?

The interest on \$1 at $4\frac{1}{2}\%$ for 8 months is $\$1 \times \frac{9}{20} \times \frac{8}{12}$, or \$.03. Since \$.03 is produced by \$1 (at the given rate for the given time), \$2.88 will require a principal of as many dollars as \$.03 is contained times in \$2.88, or 96.

Ans. \$96.

$$\text{PROOF.} \quad \$96 \times \frac{9}{20} \times \frac{8}{12} = \$2.88.$$

2. What principal will amount to \$98.88 in 8 months at $4\frac{1}{2}\%$?

The amount of \$1 at $4\frac{1}{2}\%$ for 8 months is \$1.03. If an amount of \$1.03 is produced from a principal of \$1, an amount of \$98.88 will be produced from a principal of as many dollars as \$1.03 is contained times in \$98.88, or 96.

Ans. \$96.

To find the principal, divide the given interest (or amount) by the interest (or amount) of \$1 at the given rate for the given time.

The following is an algebraic method of solving No. 1:

(1) Let x represent the required principal.

(2) The interest will be $x \times \frac{9}{200} \times \frac{8}{12}$, or $\frac{3x}{100}$.

$$(3) \quad \frac{3x}{100} = 2.88. \quad *$$

(4) Clearing of fractions, $3x = 288$.

(5) Dividing, $x = 96.$

Ans. \$96.

The following is an algebraic method of solving No. 2:

(1) Let x represent the required principal.

(2) The interest will be $x \times \frac{9}{200} \times \frac{8}{12}$, or $\frac{3x}{100}$.

(3) The amount will be $x + \frac{3x}{100}$, or $\frac{103x}{100}$.

$$(4) \quad \frac{103x}{100} = 98.88.$$

(5) Clearing of fractions, $103x = 9888$.

(6) Dividing, $x = 96.$

Ans. \$96.

3. At what rate per cent will \$723.60 produce \$36.18 interest in 1 yr. 1 mo. 10 da.?

The interest on \$723.60 at 1% for 1 yr. 1 mo. 10 da. is \$723.60 $\times \frac{1}{100} \times \frac{180}{360}$, or \$8.04. Since \$8.04 is produced by a rate of 1%, \$36.18 will require a rate of as many per cent as \$8.04 is contained times in \$36.18, or $4\frac{1}{2}$.
Ans. $4\frac{1}{2}\%$.

PROOF. \$723.60 $\times \frac{1}{100} \times \frac{180}{360} = \36.18 .

4. At what rate per cent will \$723.60 amount to \$759.78 in 1 yr. 1 mo. 10 da.?

Find the interest by subtracting the principal \$723.60 from the amount \$759.78, and proceed as in No. 3.

To find the rate, divide the given interest by the interest at 1% on the given principal for the given time.

The following is an algebraic solution of Nos. 3 and 4:

(1) Let x represent the rate.

(2) The interest will be $723.60 \times \frac{x}{100} \times \frac{400}{360}$, or $8.04x$.

(3) $8.04x = 36.18$.

(4) Clearing of decimals, $804x = 3618$.

(5) Dividing, $x = 4\frac{1}{2}$.
Ans. $4\frac{1}{2}\%$.

5. In what time will \$85.50 produce \$8.17 interest at 4%?

The interest on \$85.50 at 4% for 1 year is \$85.50 $\times \frac{4}{100}$, or \$3.42. Since \$3.42 is produced in 1 year, \$8.17 will require as many years as \$3.42 is contained times in \$8.17, or $2\frac{7}{8}$.
Ans. $2\frac{7}{8}$ years, or 2 yr. 4 mo. 20 da.

PROOF. \$85.50 $\times \frac{4}{100} \times 2\frac{7}{8}$
 $= \$85.50 \times \frac{1}{100} \times \frac{25}{8} = \8.17 .

6. In what time will \$85.50 amount to \$93.67 at 4%?

Find the interest by subtracting the principal \$85.50 from the amount \$93.67, and proceed as in No. 5.

To find the time, divide the given interest by the interest for 1 year on the given principal at the given rate.

335. The following is an algebraic solution of Nos. 5 and 6:

- (1) Let x represent the time in *years*.
- (2) The interest will be $85.50 \times \frac{4}{100} \times x$, or $3.42x$.
- (3) $3.42x = 8.17$.
- (4) Clearing of decimals, $342x = 817$.
- (5) Dividing, $x = \frac{817}{342}$.
Ans. $2\frac{7}{18}$ years, or 2 yr. 4 mo. 20 da.

336. The algebraic method consists (1) in representing the unknown quantity (principal, rate, or time) by x ; (2) finding the interest, by multiplying principal by rate by time; (3) forming an equation, by making this product equal to given interest; (4) solving the equation.

337. Written Exercises.

Find rate, time, etc.

1. Principal, \$ 2000; time, 3 yr.; interest, \$ 300. Rate?
2. Principal, \$ 1800; rate, 4%; interest, \$ 144. Time?
3. Time, 8 mo.; rate, $4\frac{1}{2}\%$; interest, \$ 2.88. Principal?
4. Principal, \$ 38; time, 2 yr.; amount, \$ 40.28. Rate?
5. Principal, \$ 140; rate, $3\frac{1}{2}\%$; time, 3 mo. 15 da. Interest?
6. Amount, \$ 39.60; rate, 4%; time, 2 yr. 6 mo. Principal?
7. Amount, \$ 484.15; rate, $3\frac{1}{2}\%$; principal, \$ 460. Time?
8. Principal, \$ 39.60; rate, 4%; time, 1 yr. 7 mo. 15 da. Amount?
9. Time, 8 yr.; rate, 3%; amount, \$ 6200. Principal?
10. Principal, \$ 7548; time, 3 mo. 5 da.; interest, \$ 119.51. Rate?
11. Principal, \$ 9000; rate, 4%; interest, \$ 632. Time?
12. Time, 2 yr. 3 mo. 20 da.; rate, 5%; amount, \$ 160.60. Principal?

13. Principal, \$ 756; rate, $3\frac{1}{4}\%$; time, 3 yr. 4 mo. 20 da.
Interest?

14. Principal, \$ 120; time, 1 yr. 2 mo. 15 da.; interest,
\$ 4.35. Rate?

15. Amount, \$ 97.57; rate, 4% ; interest, \$ 7.57. Time?

16. Time, 3 yr. 8 mo. 19 da.; rate, $4\frac{1}{2}\%$; amount, \$ 93.39.
Principal?

17. Principal, \$ 1848; rate, $3\frac{3}{4}\%$; time, 4 yr. 9 mo. 25 da.
Amount?

18. Rate, 5% ; time, 4 yr. 6 mo. 23 da.; interest, \$ 16.43.
Principal?

338. Oral Exercises.

1. In what time will \$ 100 amount to \$ 109, at 6% interest?

2. At what rate will \$ 200 produce \$ 16 interest in 2 years?

3. What principal will produce \$ 12 interest in 3 years, at 4% ?

4. In what time will \$ 300, at 4% , produce \$ 29 interest?

5. In what time will \$ 170 produce \$ 1.70 interest, at 5% ?

6. In what time will \$ 360 produce \$ 3.60 interest, at 4% ?

7. In what time will \$ 725 produce \$ 7.25 interest, at 6% ?

8. In what time will \$ 45 produce 45¢ interest, at $4\frac{1}{2}\%$?

9. In what time will \$ 72 produce \$ 1.44 interest, at 6% ?

10. Find the interest on \$ 84 for 144 days, at 5% .

11. Find the interest on \$ 125, at 5% , for 2 months 12 days.

12. At what rate will \$ 64 produce 64¢ interest in 80 days?

13. At what rate will \$ 40 produce \$ 1.20 interest in 6 months?

14. A certain principal produces \$ 120 interest at 6% . What would be the interest if the rate were 4% ?

339. Written Review Exercises.

1. What number increased by 16% of itself equals 1276?
2. A capitalist sends a commission merchant \$8670 to invest in cotton and to include commission at 2%. How much does the commission amount to?
3. A joiner worked on Monday 9 hr. 45 min., on Tuesday and Wednesday 10 hr. 45 min. each day, on Thursday and Friday 10 hr. 15 min. each day, and on Saturday 6 hr. 45 min. What was the average length of his day's work?
4. Thirty-two clerks are to distribute 36,000 letters on a certain day. Half of the clerks are experienced men and half of them new men. If each experienced man does twice as much as a new man, how many letters will be distributed by one of each kind?
5. Sold my house and farm of $9\frac{4}{5}$ acres for \$12,300. Allowing \$7000 for the house, what did I receive per acre for the land?
6. A commission merchant receives \$1071 to invest in oats at 30¢ per bushel and to cover his commission at 2% for buying. How many bushels of oats does he purchase?
Should the commission merchant deduct 2% of \$1071, or 2% of the cost of the oats?
7. What is the total weight of 4 hogsheads of sugar, weighing respectively $936\frac{1}{2}$, $1025\frac{9}{10}$, $846\frac{1}{2}$, and $987\frac{7}{15}$ pounds, deducting tare at 10 per cent?
8. The product of three factors is 3289; two of the factors are 23 and 11. What is the third factor?
9. A man received \$2.75 per day, exclusive of Sundays, during 1903. He paid \$73 for clothing for himself and family, \$15 per month rent, \$1.10 per day for provisions, \$8 per month for fuel and light, and 25¢ per day for other expenses. How much had he left at the end of the year?

BANK DISCOUNT.

340. Thomas Tierney, wishing to borrow three hundred dollars from The Borough Bank, draws up the following promissory note:

DENVER, May 16, 1903.

Three months after date I promise to pay to the order of myself Three Hundred Dollars, value received, at The Borough Bank.

\$ 300 $\frac{00}{100}$.

THOMAS TIERNEY.

As the note now stands, it is payable to Thomas Tierney. He transfers by *indorsing* it; that is, by writing his name on the back of the note. The effect of this indorsement is to transfer the note to the holder, in this case, the bank. As a bank requires at least a second person as a security for the payment of the loan, Mr. Tierney gets Herman A. Metz to indorse it also. By this indorsement, Mr. Metz agrees to pay the note if Mr. Tierney does not pay it at maturity, August 16.

The Borough Bank thereupon pays over to Thomas Tierney, or places to his credit on the books of the bank, the face of the note less the interest for 92 days, \$300 — \$ 4.60, or \$ 295.40. This interest taken in advance is called *bank discount*. The sum turned over to Thomas Tierney is called the *proceeds*.

Face of note,	\$ 300.00
Discount 92 days,	<u>4.60</u>
Proceeds,	\$ 295.40

To find the bank discount, compute the interest on the face of the note from the date of discount to the date of maturity.

To find the proceeds, deduct the discount from the face.

NOTE. — The usage of banks varies in different parts of the country, and the teacher should inform herself as to the local practice.

341. Written Exercises.

Find the discount at 6% on the following:

1. A 30-days note for \$75.
2. 15-days note for \$183.60.
3. 60-days note for \$275.40.
4. 20-days note for \$96.
5. 4-months note for \$336.

Face of note — bank discount = proceeds.

Find the proceeds, at 7%, on

6. A 6-months note for \$180.
7. A 3-months note for \$36.90.
8. A 24-days note for \$795.60.
9. A 90-days note for \$180.
10. A 72-days note for \$1000.

342. Find the discount, at 6%, on

11. A 1-month note for \$600, dated Feb. 6, 1904. Due March 6, 29 days.
12. A 2-months note for \$240, dated July 17, 1903.
13. A 3-months note for \$360, dated April 8, 1904.
14. A 4-months note for \$84, dated Dec. 24, 1905.
15. A 6-months note for \$172.60, dated March 4, 1903.
16. A 60-days note for \$240, dated July 17, 1904.
17. A 90-days note for \$360, dated April 8, 1903.

In each of the preceding examples, it has been assumed that the note has been presented for discount the day on which it was made.

In some of the following examples, the notes are discounted at a later date, and the *term of discount* is to be ascertained; that is, the time between the date of discount and that of maturity.

The term of discount of a 30-days note dated May 1, and discounted May 19, is the time from May 19 to May 31, 12 days.

343. In the following examples, find (a) date of maturity; (b) term of discount; (c) discount; (d) proceeds.

NOTE. — The pupil that works without thinking, frequently finds the difference in time between the two dates given in the problem and uses this as the term of discount. The time between the dates given below shows in each case the time the note was *not* in the possession of the bank.

Dated.	Face.	Time.	Discounted.	Rate.
18. July 16, 1902 ;	\$87.60 ;	30 days ;	August 11, 1902 ;	6 %

This note is due 30 days after July 16, which is August 15. If the bank discounts it August 11, 4 days before it is payable, it deducts 4 days' interest, which is 6 cents.

Answers — Date of maturity Aug. 15, 1902.

Term of discount 4 days.

Discount 6 cents.

Proceeds \$87.54.

19. Date, Sept. 9, 1902; face, \$124.18; time, 4 months; discounted, Nov. 18, 1902; rate, 8%.

20. Date, Dec. 5, 1902; face, \$504.60; time, 30 days; discounted, Dec. 12, 1902; rate, 7%.

21. Date, Nov. 14, 1903; face, \$72.36; time, 3 months; discounted, Dec. 20, 1903; rate, 6%.

22. Date, Oct. 30, 1903; face, \$234; time, 90 days; discounted, Jan. 5, 1904; rate, 6%.

23. Date, Jan. 2, 1904; face, \$95.90; time, 2 months; discounted, Feb. 13, 1904; rate, 6%.

24. Date, Aug. 5, 1904; face, \$164; time, 60 days; discounted, Aug. 31, 1904; rate, 8%.

25. Date, Feb. 27, 1904; face, \$83.20; time, 100 days; discounted, March 9, 1904; rate, 6%.

DISCOUNT OF INTEREST-BEARING NOTES.

344. Written Problems.

BROOKLYN, N.Y., Oct. 16, 1904.

Sixty days after date I promise to pay to the order of John Karst, One Hundred Forty-eight $\frac{5}{100}$ Dollars, value received, with interest at 6%.

\$148 $\frac{5}{100}$.

DANIEL KELLY.

1. Find the proceeds of the above note if discounted Dec. 1, 1904, at 6%.

At maturity, Dec. 15, 1904, there is due \$148.50 with \$1.49 interest for sixty days, a total of \$149.99. If it is discounted Dec. 1, 14 days before maturity, the bank deducts 14 days' interest on \$149.99, which is 35 cents, and pays over to John Karst the proceeds, \$149.64, *Ans.*

To find the bank discount of an interest-bearing note, compute the interest on the amount due at maturity from the time of discount to the date of maturity.

2. Find the proceeds of a 90-days note for \$175, bearing interest at 6%, discounted 33 days after date, at 6%.

3. Find the proceeds of a 60-days note for \$350, bearing interest at 6%, discounted at 6%, 10 days after date.

4. Find the proceeds of a 3-months note for \$840, bearing interest at 7%, discounted at bank 47 days before maturity, at 8%.

5. A 4-months note for \$720, dated March 17, 1905, bearing interest at 6%, is discounted at 7%, May 10. What are the proceeds?

6. The following note was discounted at 6%, Sept. 19, 1904. Find the proceeds.

MILWAUKEE, Wis., June 30, 1904.

Four months after date I promise to pay Thomas Cacciola, or order, Five Hundred Dollars, value received, with interest at 6 per cent.

\$500 $\frac{00}{100}$.

GEORGE H. GREENE.

345. To find the face of note, rate of discount, or term.

1. The discount at 6% on a note having 84 days to run, is \$10.50. Find the face of the note.

The discount on \$1 for 84 days at 6% = $\$1 \times \frac{1}{100} \times \frac{14}{30}$, or \$.014. If \$.014 is the discount on a note for \$1, \$10.50 will be the discount on a note for as many dollars as \$.014 is contained times in \$10.50, or \$750. *Ans.* \$750.

2. The proceeds of a note having 84 days to run, discounted at 6%, are \$739.50. Find the face of the note.

The discount on \$1 for 84 days at 6% is \$.014; the proceeds are \$1 - \$.014, or \$.986. If \$.986 are the proceeds of a note for \$1, \$739.50 will be the proceeds of a note for as many dollars as \$.986 is contained times in \$739.50, or \$750. *Ans.* \$750.

To find the face of a note, divide the given discount (or proceeds) by the discount (or proceeds) of \$1 for the given term at the given rate.

3. The discount on a note for \$750 having 84 days to run is \$10.50. What is the rate of discount?

The discount on \$750 at 1% for 84 days is $\$750 \times \frac{1}{100} \times \frac{14}{30}$, or \$1.75. If \$1.75 is produced by a rate of 1%, \$10.50 will be produced by a rate of as many per cent as \$1.75 is contained times in \$10.50, or 6%.

To find the rate of discount, divide the given discount by the discount at 1% on the given sum for the given term.

4. The discount at 6% on a note for \$750 is \$10.50. How many days has the note to run?

The discount on \$750 at 6% for 1 day is $\$750 \times \frac{6}{100} \times \frac{1}{30}$, or \$.125. If \$.125 is the discount for 1 day, \$10.50 will be the discount for as many days as \$.125 is contained times in \$10.50, or 84 days.

To find the term of discount, divide the given discount by the discount for 1 day on the given sum at the given rate.

- 346.** Note.—To solve by the algebraic method, use x to represent the unknown quantity.

347. Written Exercises.

1. Three-months note; face, \$108; rate, 6%. Find proceeds.
2. 90-days note; face, \$360; discount, \$6.30. Find rate.
3. Proceeds, \$717.60; rate, 5%; face, \$720. Find term.
4. Discount, \$11.20; rate, 7%; term, 48 days. Find face.
5. 15-days note; face, \$1560; rate, 6%. Find discount.
6. Term, 20 days; face, \$158.40; proceeds, \$157.96. Find rate.
7. Rate, 7%; discount, \$2.10; face, \$150. Find term.
8. Two-months note; discount, \$14.70; rate, 7%. Find face.
9. For what amount must a 60-days note be drawn so that the proceeds will be \$300 when the rate of discount is 8 per cent?
10. A note for \$120 was discounted at a bank March 15, 1905. What is the date of the maturity of the note, the proceeds being \$119.52 and the rate of discount 6 per cent?
11. Find the proceeds of a 6-months note for \$875 drawn Jan. 2, 1906, and discounted at 6 per cent 35 days after that date.
12. A merchant bought 300 barrels of flour at \$4.75 per barrel, cash, and sold it for \$5 per barrel, taking in payment a 60-days note for the amount. If he has the note discounted immediately at a bank, at 7 per cent, what does he gain by the transaction?
13. What will be the face of a 30-days note, the proceeds of which when discounted at a bank at 6% will pay for 3000 bushels corn at $49\frac{3}{4}$ ¢ per bushel?
14. The proceeds of a note for \$1200, due March 15, 1904, and discounted at 6%, were \$1184.80. When was it discounted?

INTEREST BY ALIQUOT PARTS.

348. Written Exercises.

1. Find the interest on \$387.45, for 2 yr. 8 mo. 18 da., at 7%.

$$\underline{\$387.45} \times .07.$$

\$27.1215 interest for 1 yr.

27.1215 interest for 1 yr.

6 mo. = $\frac{1}{2}$ yr. 18.5607 interest for 6 mo.

2 mo. = $\frac{1}{6}$ (of 6 mo.) 4.5202 interest for 2 mo.

15 da. = $\frac{1}{2}$ (of 2 mo.) 1.1301 interest for 15 da.

3 da. = $\frac{1}{3}$ (of 15 da.) .2260 interest for 3 da.

Ans. \$73.68 interest for 2 yr. 8 mo. 18 da.

2. Find the interest on \$432.90, at 6%, for 1 yr. 7 mo. 12 da.

$$\underline{\$432.90} \times .06.$$

interest for 1 yr.

6 mo. = $\frac{1}{2}$ yr. interest for 6 mo.

1 mo. = $\frac{1}{6}$ (of 6 mo.) interest for 1 mo.

10 da. = $\frac{1}{2}$ (of 1 mo.) interest for 10 da.

2 da. = $\frac{1}{3}$ (of 10 da.) interest for 2 da.

interest for 1 yr. 7 mo. 12 da.

3. Find the amount of \$874.16, at 5%, for 1 yr. 9 mo. 4 da.

$$\underline{\$874.16} \text{ principal.}$$

43.708 interest for 1 yr.

6 mo. = $\frac{1}{2}$ yr. interest for 6 mo.

3 mo. = $\frac{1}{6}$ (of 6 mo.) interest for 3 mo.

3 da. = $\frac{1}{3}$ (of 3 mo.) interest for 3 da.

1 da. = $\frac{1}{3}$ (of 3 da.) interest for 1 da.

amount for 1 yr. 9 mo. 4 da.

4. What is the amount of \$95.72, for 3 yr. 6 mo. 20 da., at 5%?

$$\underline{\$95.72} \text{ principal.}$$

9.572 interest for 2 yr.

4.786 interest for 1 yr.

1 yr. = $\frac{1}{2}$ (of 2 yr.) interest for 6 mo.

6 mo. = $\frac{1}{2}$ yr. interest for 20 da.

20 da. = ? of 6 mo. amount for 3 yr. 6 mo. 20 da.

5. Interest of \$1806.45, at 4%, for 1 yr. 7 mo. 25 da.

1 yr., 6 mo., 1 mo., 15 da., 5 da., 5 da.

6. Interest for 10 mo. 29 da., at 4%, on \$380.40.

$$\underline{\$380.40 \times .04.}$$

$\underline{\$15.2160}$ interest for 1 yr.

$$\begin{array}{l} 1 \text{ mo.} = \frac{1}{12} \text{ yr.} & \text{interest for 1 mo. } \} \text{ deduct from interest} \\ 1 \text{ da.} = \frac{1}{30} \text{ mo.} & \text{interest for 1 da. } \} \text{ for 1 yr.} \\ \hline & \text{interest for 10 mo. 29 da.} \end{array}$$

7. Amount, at 6%, of \$125.73, for 2 yr. 10 mo. 4 da.

8. Interest on \$84.66, at 7%, for 1 yr. 4 mo. 12 da.

9. Interest, at 5%, for 4 yr. 2 mo. 7 da., on \$250.

10. Amount of \$1000, at 6%, for 33 days.

349. When the time is less than a year, the following facts should be remembered:

6% for a year is 1 per cent for 60 days.

5% for a year is 1 per cent for 72 days.

$4\frac{1}{2}\%$ for a year is 1 per cent for ? days.

$4\frac{1}{2}\%$ for a year is 1 per cent for ? days.

11. Find the interest for 81 days, at 5%, on \$876.40.

Since 5% for a year is 1% for 72 days, we have :—

72 days' interest is 1% of principal, or \$8.764

9 days' interest is $\frac{1}{8}$ of 72 days, or $\frac{1.095}{8}$

$\underline{\$9.86}$ interest for 81 days.

12. Amount of \$954, at 4%, for 4 mo. 10 da.

Principal \$954.00

8 months' interest = 1% 0.54

1 mo. = $\frac{1}{8}$ (of 8 mo.) 0.18

10 da. = $\frac{1}{2}$ (of 1 mo.) $\underline{\quad}$

amount for 4 mo. 10 da.

18. Interest of \$1874, at $4\frac{1}{2}\%$, for 93 da.

$$80 \text{ days} = 1\%$$

10 days

2 days

1 day

14. Interest of \$753.20, at 5%, for 158 days.

$$72 \text{ da.}, 72 \text{ da.}, 12 \text{ da.}, 2 \text{ da.}$$

15. Amount of \$1234.50, for 193 days, at 6%.

$$60 \text{ da.}, 120 \text{ da.}, 12 \text{ da.}, 1 \text{ da.}$$

16. Find the proceeds of a 90-days note, for \$873.60, at 6%.

Face	\$873.60	
60 da.	8.736	Deduct
30 da.	4.368	
		\$860.50
		proceeds.

17. Find the discount on a 3-months note, for \$1596, at 6%.

18. What are the proceeds of a 6-months note, for \$785, discounted at 6%.

19. Find the interest on \$484.40, for 1 yr. 3 mo. 17 da., at 7%.

20. Find the amount of \$683, for 3 yr. 4 mo. 11 da., at $4\frac{1}{2}\%$.

350. N.B.—Do not use unnecessary figures.

21. Principal, \$360; 5%; 3 yr. 7 mo. 18 da. Interest?

22. Principal, \$613; $4\frac{1}{2}\%$; 157 da. Amount?

23. Principal, \$1774; $3\frac{3}{4}\%$; 17 mo. 23 da. Interest?

24. Principal, \$875; 6%; 2 yr. 3 mo. 1 da. Amount?

25. Principal, \$976; 7%; 325 da. Interest?

351. By the *time* of a note is meant the number of days, etc., for which it is drawn. In these four examples the note is discounted the day it is made.

26. Face of note, \$ 254; time, 30 days; 7%. Proceeds?
27. Face of note, \$ 515; time, 6 months; 5%. Discount?

28. Face of note, \$ 493; time, 60 days; 8%. Proceeds?
29. Face of note, \$ 717; time, 15 days; 6½%. Discount?

352. Find the exact number of days. Take 360 days to year.

30. Principal, \$1836.50; 6%; Jan. 2 to Dec. 1. Amount?
31. Principal, \$1295.70; 7%; March 8 to April 9. Interest?

32. Principal, \$ 765.90; 4%; Oct. 1 to Dec. 17. Interest?
33. Principal, \$ 275.84; 5½%; May 9 to July 3. Amount?

353. By the *term* of a note is meant the number of days it has to run after it has been discounted.

34. Face of note, \$ 100; term, 60 days; 7%. Discount?
35. Face of note, \$ 200; term, 90 days; 6½%. Proceeds?
36. Face of note, \$ 300; term, 24 days; 5½%. Discount?
37. Face of note, \$ 400; term, 117 days; 8%. Proceeds?

354. In examples 38-41, inclusive, find the time by compound subtraction.

38. Principal, \$ 25.83; 6%; Jan. 14, 1902, to Sept. 5, 1904. Interest?
39. Principal, \$ 47.96; 5%; Feb. 6, 1903, to Aug. 1, 1906. Amount?
40. Principal, \$ 85.30; 7%; March 25, 1904, to Jan. 13, 1907. Interest?
41. Principal, \$ 75; 4%; April 15, 1900, to Feb. 6, 1907. Amount?

REVIEW.**355. Oral Problems.**

1. Out of 500 pupils, 50 are absent. What is the per cent of attendance?
2. A can do a piece of work in 4 days; B can do it in 4 days. In what time can A and B do it, if they work together?
3. What is the interest of \$1500, for 60 days, at 6%?
4. In a certain class $\frac{1}{2}$ of the pupils are under 10 years, $\frac{1}{3}$ of them are between 10 and 12, and the rest are over 12. What per cent are over 12 years?
5. If a bushel of English walnuts costs \$1.60, what will 6 quarts cost?
6. A man put 5 gal. 2 qt. of syrup into bottles holding 2 quarts each. How many bottles did it require?
7. If $\frac{3}{4}$ of a yard of cloth costs $\frac{4}{5}$ of a dollar, what will $\frac{4}{5}$ of a yard cost?
8. If 9 pounds of sugar cost 48¢, what will 12 pounds cost?
9. What is the difference between $\frac{3}{4}$ of $6\frac{1}{2}$ and $\frac{3}{4}$ of $4\frac{1}{2}$?
10. How many eggs, at the rate of 15 for 25 cents, can be bought for 60¢?
11. A merchant's receipts are \$1200; his gain is 20 per cent. What part of his receipts is profit?
12. If 3 men earn \$72 in 8 days, how many dollars will 5 men earn in 11 days?
13. If a dealer loses 25% by selling a horse for \$225, what per cent would he gain or lose by selling the horse for \$325?
14. If A can do a piece of work in 2 days, B in 3 days, and C in 4 days, in what time can they do it, working together?

356. Written Problems.

1. A man sold 18 barrels sugar, each containing 306 pounds; 21 barrels, each containing 297 pounds; 5 barrels, each containing 291 pounds. What is the average weight per barrel?

2. Three men engage in a business venture. One furnishes \$3000, another furnishes \$5000, a third furnishes \$4000. They gain \$1800. What is each one's share of the profit?

What part of the money did the first furnish? What part of the profit should he receive?

3. Three ounces is what per cent of 5 pounds?

4. What is the product of $\frac{1}{8}$ of $\frac{2}{3}$ of $15\frac{1}{2}$. State the result in decimals.

5. What is $87\frac{1}{2}\%$ of \$896? \$896 is $87\frac{1}{2}\%$ of what sum?

6. What number is that which, diminished by $2\frac{1}{2}$, will leave $2\frac{1}{8}\frac{1}{2}$.

7. How long will 200 pounds flour last 18 persons if each person is allowed $1\frac{1}{4}$ pounds per day?

8. If $\frac{1}{4}$ of $\frac{1}{2}$ of a ship cost \$84,000, what is $\frac{1}{2}$ of it worth?

9. The dividend was \$4689.036, the quotient .027, what was the divisor?

10. Harry Hedge earns \$12 a week. He pays \$4.25 for board, \$0.625 for car fare, \$0.375 for library fees, and \$4.875 for other expenses. In how many weeks would he save \$97.50.

11. For how long must \$450 be at interest, at five per cent per annum, to amount to \$481.62?

12. Divide 320 acres of land among A, B, and C, so that A shall have 15 acres more than B, and C shall have 27 acres more than B.

DENOMINATE NUMBERS.**357. Inductive Exercises.**

1. Change 1 yd. 1 ft. to inches.
2. Change 1 yd. 1 ft. 1 in. to inches.
3. Change 49 inches to yards, feet, etc.
4. Change 49 pints to gallons, etc.
5. Add 4 lb. 8 oz. and 4 lb. 8 oz.
6. From 9 pounds take 4 lb. 8 oz.
7. Multiply 4 lb. 8 oz. by 2.
8. Divide 9 pounds by 2.
9. Divide 9 pounds by 4 lb. 8 oz.
10. How many inches in $\frac{3}{4}$ yd.?
11. How many feet and inches in .75 yd.?
12. 75 per cent of a yard = ?
13. What fraction of a yard is 27 inches?
14. Change 2 ft. 3 in. to the decimal of a yard.
15. 1 ft. 6 in. is what per cent of 2 feet?
16. Multiply 9 yd. 18 in. by 7.
17. From 18 lb. 6 oz. take 9 lb. 12 oz.

358. Troy Weight.

24 grains (gr.) = 1 pennyweight (pwt.)

20 pennyweight = 1 ounce (oz.)

12 ounces = 1 pound (lb.)

Troy weight is used in weighing gold, silver, precious stones, etc.

359. English Money.

12 pence (d.) = 1 shilling (s.)

20 shillings = 1 pound (£)

A farthing is a quarter of a penny.

REDUCTION DESCENDING.**360. Change 43 yd. 2 in. to inches.**

Write 43 yd. 0 ft. 2 in., inserting the missing denomination, feet. Above 0 ft. write the number of feet in a yard, and above the 2 in. the number of inches in a foot. Since there are 3 feet in a yard, in 43 yards there are 43 times 3 feet, or 129 feet. This is written in the column of feet. Since there are 12 inches in a foot, if 129 feet there are 129 times 12 inches, or 1550 inches. Add 2 inches, making 1550 inches, which is written in the column of inches, and cancel 129 feet.

3 ft.	12 in.
43 yd.	0 ft.
129 ft.	1550 in.

Ans. 1550 in.

In working this example, 3 and 12 are used as the multipliers instead of 43 and 129. At the time the 9 of 129 is multiplied by 12, the 2 is added in, the pupil saying 12 nines are 108, and 2 are 110, writing the 0 ; 12 twos are 24, and 11 are 35, writing the 5 ; etc.

361. Written Exercises.

Change :

1. 4 yards 2 feet 8 inches to inches.
2. 2 miles 46 rods 3 yards to yards.
3. 3 pecks 5 quarts 1 pint to pints.
4. 6 bushels 3 pecks 6 quarts to quarts.
5. 2 gallons 3 quarts 1 pint to pints.
6. 7 gallons 1 quart 1 pint to pints.
7. 4 ounces 12 pennyweights 3 grains to grains.
8. 2 pounds 16 pennyweights 14 grains to grains.
9. 6 pounds 9 shillings 7 pence to pence.
10. 8 pounds 18 shillings 4 pence to pence.
11. 3 wk. 4 da. 13 hr. to hours.
12. $\frac{4}{7}$ of a week to hours.
13. $\frac{7}{8}$ of a mile to yards.
14. .25 of a rod to inches.

REDUCTION ASCENDING.

362. Change 1550 inches to yards, feet, etc.

Above 1550 in. write 12 in., the number in a foot. Dividing 1550 inches by 12 inches we obtain the quotient 129, the number of feet, and 2 inches remainder. Write the remainder in the column of inches and 129 ft. to the left of 1550 in. Reduce 129 ft. to yards, writing the result, 43 yd., as shown above, and cancelling 129 ft.

	3 ft. 12 in.
	<u>129 ft. 1550 in.</u>
	43 yd. 0 ft. 2 in.

Ans. 43 yd. 2 in.

363. Written Exercises.

Change :

1. 4530 feet to rods, yards, etc.
2. 6324 yards to miles, rods, etc.
3. 244 pints to bushels, pecks, etc.
4. 467 quarts to bushels, pecks, etc.
5. 923 pints to gallons, quarts, etc.
6. 785 pints to gallons, quarts, etc.
7. 543 pennyweights to pounds, etc.
8. 175 grains to pennyweights, etc.
9. 625 pence to pounds, shillings, etc.
10. 836 shillings to pounds, etc.
11. 8423 min. to days, hours, etc.
12. 2348 inches to yards, etc.

ADDITION OF DENOMINATE NUMBERS.

364. Find the sum :

11 yd.	2 ft.	8 in.	8 in. + 10 in. + 5 in. = 23 in. = 1 ft.
	1 ft.	10 in.	11 in. Write 11 in. and carry 1 ft.
4 yd.	0 ft.	5 in.	1 ft. + 1 ft. + 2 ft. = 4 ft. = 1 yd. 1 ft.
16 yd.	1 ft.	11 in.	Write 1 ft. and carry 1 yd.

Ans. 1 yd. + 4 yd. + 11 yd. = 16 yd. Write 16 yd.

365. Written Exercises.

Find sums:

$$\begin{array}{r} \text{1. } 8 \text{ mi. } 44 \text{ rd. } 3 \text{ yd.} \\ \quad 6 \text{ mi. } 298 \text{ rd. } 4 \text{ yd.} \\ \hline \quad \quad \quad 67 \text{ rd. } 1 \text{ yd.} \end{array}$$

$$\begin{array}{r} \text{4. } 243 \text{ gal. } 2 \text{ qt. } 1 \text{ pt.} \\ \quad 168 \text{ gal. } 3 \text{ qt. } 1 \text{ pt.} \\ \hline \quad \quad \quad 1 \text{ qt. } 1 \text{ pt.} \end{array}$$

$$\begin{array}{r} \text{2. } 27 \text{ rd. } 3 \text{ yd. } 2 \text{ ft.} \\ \quad 3 \text{ rd. } 2 \text{ yd. } 1 \text{ ft.} \\ \hline \quad \quad \quad 78 \text{ rd. } 4 \text{ yd. } 2 \text{ ft.} \end{array}$$

$$\begin{array}{r} \text{5. } 4 \text{ lb. } 10 \text{ oz. } 14 \text{ pwt.} \\ \quad 3 \text{ lb. } 9 \text{ oz. } 16 \text{ pwt.} \\ \hline \quad \quad \quad 1 \text{ lb. } 11 \text{ oz. } 7 \text{ pwt.} \end{array}$$

$$\begin{array}{r} \text{3. } 8 \text{ bu. } 3 \text{ pk. } 5 \text{ qt.} \\ \quad 16 \text{ bu. } 2 \text{ pk. } 3 \text{ qt.} \\ \hline \quad \quad \quad 4 \text{ bu. } 3 \text{ pk. } 7 \text{ qt.} \end{array}$$

$$\begin{array}{r} \text{6. } 8 \text{ oz. } 9 \text{ pwt. } 21 \text{ gr.} \\ \quad 3 \text{ oz. } 11 \text{ pwt. } 6 \text{ gr.} \\ \hline \quad \quad \quad 17 \text{ pwt. } 23 \text{ gr.} \end{array}$$

SUBTRACTION OF DENOMINATE NUMBERS.

- 366.** From 35 yd. 1 ft. 4 in.

Take 19 yd. 2 ft. 8 in.

15 yd. 1 ft. 8 in. *Ans.*

Since 8 in. is greater than 4 in., we must use 1 ft. 4 in., or 16 in., as the minuend. 16 in. —

8 in. = 8 in. As the minuend now contains 0 ft., 1 yd. is taken from 35 yd. Changing the yard to 3 ft., and deducting 2 ft., leaves 1 ft, 34 yd. — 19 yd. = 15 yd.

367. Written Exercises.

Find differences:

$$\begin{array}{r} \text{1. } 183 \text{ rd. } 4 \text{ yd. } 1 \text{ ft.} \\ \hline \quad \quad \quad 68 \text{ rd. } 5 \text{ yd. } 2 \text{ ft.} \end{array}$$

$$\begin{array}{r} \text{4. } 29 \text{ gal. } 2 \text{ qt.} \\ \hline \quad \quad \quad 28 \text{ gal. } 3 \text{ qt. } 1 \text{ pt.} \end{array}$$

$$\begin{array}{r} \text{2. } 91 \text{ mi. } 83 \text{ rd. } 2 \text{ yd.} \\ \hline \quad \quad \quad 26 \text{ mi. } 122 \text{ rd. } 4 \text{ yd.} \end{array}$$

$$\begin{array}{r} \text{5. } 8 \text{ lb. } 3 \text{ oz. } 8 \text{ pwt.} \\ \hline \quad \quad \quad 6 \text{ lb. } 8 \text{ oz. } 10 \text{ pwt.} \end{array}$$

$$\begin{array}{r} \text{3. } 3 \text{ pk. } 1 \text{ qt.} \\ \hline \quad \quad \quad 1 \text{ pk. } 4 \text{ qt. } 1 \text{ pt.} \end{array}$$

$$\begin{array}{r} \text{6. } £ 24 \text{ } 6\text{s. } 3\text{d.} \\ \hline \quad \quad \quad £ 3 \text{ } 9\text{s. } 8\text{d.} \end{array}$$

MULTIPLICATION OF DENOMINATE NUMBERS.

- 368.** Multiply 34 yd. 2 ft. 9 in. by 7.
244 yd. 1 ft. 3 in.

7 times 9 in. = 63 in. = 5 ft. 3 in. Write 3 in. 7 times 2 ft. = 14 ft. Carry 5 ft., making 19 ft., or 6 yd. 1 ft. Write 1 ft. Multiply 34 yd. by 7, adding in 6 yd. when the 4 is multiplied.

369. Written Exercises.

Find products:

- | | |
|------------------------------|--------------------------------|
| 1. 6 mi. 24 rd. 4 yd. by 9. | 6. .3 gal. 1 qt. 1 pt. by 32. |
| 2. 36 rd. 4 yd. 2 ft. by 12. | 7. 8 lb. 4 oz. 12 pwt. by 10. |
| 3. 24 bu. 3 pk. 6 qt. by 14. | 8. 16 oz. 12 pwt. 20 gr. by 4. |
| 4. 2 pk. 3 qt. 1 pt. by 36. | 9. £4 12s. 6d. by 20. |
| 5. 11 gal. 2 qt. 1 pt. by 8. | 10. £28 16s. 9d. by 7. |

DIVISION OF DENOMINATE NUMBERS.

- 370.** Divide 244 yd. 1 ft. 3 in. by 7.
34 yd. 2 ft. 9 in. *Ans.*

The quotient of 244 yd. divided by 7 is 34 yd., with a remainder of 6 yd. Reducing 6 yd. to ft. and adding in 1 ft., the dividend is 19 ft. 19 ft. + 7 = 2 ft. with 5 ft. remainder. 5 ft. 3 in. = 63 in. 63 in. + 7 = 9 in.

371. Written Exercises.

Find quotients:

1. 44 mi. 124 rd. 2 yd. by 8.
2. 14 yd. 1 ft. 9 in. by 21.
3. 37 bu. 1 pk. 2 qt. by 6.
4. 12 bu. 3 pk. 6 qt. by 18.
5. 7 gal. 3 qt. 1 pt. by 3.

6. 3 gal. 1 pt. by 5.
7. 28 lb. 10 oz. 16 pwt. by 24.
8. 4 oz. 10 pwt. 3 gr. by 9.
9. £ 24 17s. 4d. by 16.
10. £ 3 7s. 6d. by 10.

372. Divide 244 yd. 1 ft. 3 in. by 34 yd. 2 ft. 9 in.

In dividing one concrete number by another concrete number, the divisor and the dividend must be of the same denomination. Thus, to divide \$2 by 25¢, we change the dividend to cents, 200 cents + 25 cents, or the divisor to dollars, $\$2 \div \$\frac{1}{4}$. The quotient is 8, an abstract number; that is, 25 cents is contained in 200 cents 8 times.

$$\begin{aligned}244 \text{ yd. } 1 \text{ ft. } 3 \text{ in.} &= 8799 \text{ in.}; 34 \text{ yd. } 2 \text{ ft. } 9 \text{ in.} = 1257 \text{ in.} \\+ 1257 \text{ in.} &= 7, \text{ Ans.}\end{aligned}$$

The result would be the same if we divided $733\frac{1}{4}$ ft. by $104\frac{1}{4}$ ft., or $244\frac{1}{3}$ yd. by $34\frac{1}{3}$ yd.

373. Written Exercises.

Find quotients:

1. 4 mi. 36 rd. 1 yd. by 6 rd. 3 yd.
2. 88 rd. 2 yd. 2 ft. by 8 rd. 4 yd. 2 ft.
3. 21 bu. 2 pk. 4 qt. by 1 bu. 3 pk. 4 qt.
4. 15 bu. 1 pk. by 3 pk. 6 qt. 1 pt.
5. 60 gal. 1 pt. by 4 gal. 2 qt. 1 pt.
6. 16 gal. 3 qt. 1 pt. by 2 qt. 1 pt.
7. 17 lb. 11 oz. 10 pwt. by 8 lb. 11 oz. 15 pwt.
8. 1 lb. 2 oz. 18 pwt. by 3 oz. 14 pwt. 12 gr.
9. £24 16s. 8d. by £18 12s. 6d.
10. £2 14s. 3d. by £8 2s. 9d.

374. Oral Problems.

1. What will be the cost of 3 lb. 7 oz. of tea, at 64¢ per pound?
2. How many feet in $2\frac{1}{4}$ rods?
3. At $37\frac{1}{2}$ ¢ per peck, what shall I receive for 4 bushels of potatoes?
4. What will be the cost of a ton of hay at $97\frac{1}{2}$ ¢ per cwt.?
5. If slate pencils cost 2 mills each, how many can be bought for \$4?
6. At \$5.00 per ton, how many pounds of coal can be bought for 1¢?
7. Find the cost of 3 T. 480 lb. coal at \$5 per ton.
8. At \$5 per ton, how many tons and pounds of coal can I buy for \$10.80?
9. Find the cost of 4 yd. 1 ft. of ribbon, when 2 yd. 2 ft. cost 40 cents.
10. In $2\frac{1}{4}$ pecks, how many quarts?
11. How many hours in $\frac{1}{6}$ of a day?
12. 1.25 pecks are how many quarts?
13. At \$12 per ounce, what is $\frac{1}{6}$ of a pound of gold worth?
14. How many feet in a quarter of a mile?
15. How many tablespoons, each weighing 2 ounces, can be made from 2 lb. 10 oz. of silver?

375. Written Problems.

1. What will be the cost of 150 yards silk at 3/6 per yard? $8/6 = 3s. 6d.$, read three and sixpence.
2. If £ 1 = \$ 4.8665, what will be the cost in U. S. money of 75 books at 18 pence each?

3. A merchant sells 37 coats at £ 3 5s. each, less 10%. What is the amount of his bill in English money?
4. Find 25% of £ 183 14s. 8d.
5. A silver dollar weighs $412\frac{1}{2}$ grains. How many ounces of pure silver are there in 1000 silver dollars if the coin is $\frac{9}{10}$ pure silver?
6. The wheels of an engine being 16 ft. 8 in. in circumference, and the number of revolutions 150 per minute, how far does it go in an hour? Give answer in miles and rods.
7. What fractional part of 30 rd. 5 yd. 1 ft. is 8 rd. 4 yd. 2 ft.?
8. What decimal part of a mile is 39.27 yd.?
9. 3 bu. 1 pk. 5 qt. is what per cent of 20 bu. 1 pk. 6 qt.?
10. If a letter-carrier in delivering letters takes 47,520 steps in a day, each step averaging 20 inches, how many miles does he walk?
11. 43 gal. 3 qt. 1 pt. alcohol are sold for \$ 70.20. What is the price per gallon?
12. After taking out 15% of the grain in a bin, there remained 40 bu. 3 pk. 5 qt. How many bushels were there at first?
13. A merchant bought 51 tons 17 cwt. 3 qr. 25 lb. of wool, and sold 27 tons 4 cwt. 2 qr. 27 lb. Of the remainder, one-half was lost by fire. How much had he left?
- 28 lb. = 1 quarter; 4 quarters = 1 cwt.
14. An invoice of wool weighs 32 tons 17 cwt. 2 qr. 11 lb. State the value in £ s. d., at 10d. sterling per pound.
- 1 ton = 2240 lb.
15. How many minutes in February, 1904?

16. If a locomotive runs 25 mi. 48 rd. in 50 minutes, how far will it run in 12 hours?

Give answer in miles and decimals of a mile.

17. I wish to put 111 bu. 2 pk. 4 qt. of grain into 47 bags. What quantity must each contain?

18. If a river current carries a raft of lumber at the rate of 4 miles 180 rods per hour, how long will it take the raft to float 365 miles?

19. Bought 28,500 pounds of hay at \$12 $\frac{1}{2}$ a ton, and sold it at \$0.87 $\frac{1}{4}$ per hundredweight. What was the gain?

376. 1 pound Troy = 5760 grains.

1 pound Apothecaries' = 5760 grains.

1 pound Avoirdupois = 7000 grains.

How many grains in a Troy ounce? In an Avoirdupois ounce?

1. Find the value of a dozen silver spoons, each weighing 3 oz. 5 pwt., at \$1.20 per oz.

2. A gold chain weighs 384 grains. What is its cost at \$1.15 per pwt.?

3. Add 4 lb. 6 oz. 18 gr., 5 oz. 9 pwt., 3 lb. 20 gr., and 9 lb. 11 oz. 15 pwt. 5 gr.

4. How many spoons, each weighing 2 oz. 18 pwt., can be made from 5 lb. 9 oz. 12 pwt. silver?

5. What fraction of a pound Avoirdupois is a pound Troy? What per cent of an ounce Avoirdupois is a Troy ounce?

6. What is the value, at \$1.60 per oz. Troy, of a silver pitcher weighing 4 lb. 8 oz. Avoirdupois?

7. At 60¢ per ounce, what is the value of the silver contained in a half-dollar, which weighs 192.9 grains, $\frac{9}{10}$ being pure silver?

8. What per cent of a lb. Avoirdupois is a Troy pound?

MISCELLANEOUS.**377. Oral Problems.**

1. If 4 books cost \$ 1.25, what will a dozen cost ?
2. If 3 pounds of sugar cost $16\frac{1}{2}\text{¢}$, what will be the cost of 50 pounds ? 1 pound costs $5\frac{1}{2}\text{¢}$, etc.
3. If 48 pounds of tea cost \$ 20, what will 12 pounds cost ? 12 pounds will cost $\frac{1}{4}$ of \$ 20. •
4. Bought 17 yards of cloth for \$ 30. How many yards could I have bought for \$ 90 ?
5. If 36 men do a piece of work in 105 days, how long will it take 72 men to do it ?
6. If 7 railway trucks weigh 14 tons, how much would 29 trucks weigh ?
7. How long will it take 8 horses to plough a field, if 3 horses can do it in 8 days ?
8. What is the height of a steeple that casts a shadow of 300 feet, if an 8 foot pole casts a shadow of 12 feet.
9. If 18 men mow 90 acres of grass in 5 days, how many acres will 36 men mow in 5 days ? In 10 days ?
10. If 60 yd. carpet $\frac{1}{4}$ yard wide will cover a floor, how many yards $\frac{1}{4}$ yard wide will be required ?

378. Written Problems.

1. A piece of cloth, measured with a yard measure that is 1 inch too short, appears to be 25 yards long. What is its true length ?
2. Exchanged 40 yd. muslin, worth $10\frac{1}{2}\text{¢}$ per yard, for 15 yards linen. What is the value of the linen per yard ?

3. If 3 men or 6 women can do a piece of work in 56 days, in what time will 1 man and 2 women working together do it?

4. If 5 men can do as much in a day as 8 boys, how long will it take 32 boys to finish a piece of work which 15 men can do in 12 days?

5. If \$100 gain \$4 in 1 year, what will \$350 gain in $3\frac{1}{2}$ years?

6. If 48 horses in 10 days consume 180 bushels oats, how many bushels will 32 horses consume in 10 days? In 12 days? In 15 days?

7. If 5 men mow 45 acres of grass in 6 days, in how many days will 12 men mow 90 acres?

379. If 5 men mow 45 acres in 6 days,

$$1 \text{ man will mow } 45 \text{ acres in } 6 \text{ days} \times 5.$$

$$1 \text{ man will mow } 1 \text{ acre in } \frac{6 \text{ days} \times 5}{45}.$$

$$12 \text{ men will mow } 1 \text{ acre in } \frac{6 \text{ days} \times 5}{45 \times 12}.$$

$$12 \text{ men will mow } 90 \text{ acres in } \frac{6 \text{ days} \times 5 \times 90}{45 \times 12}.$$

$$\text{ Cancelling, } \frac{\cancel{6} \text{ days} \times \cancel{5} \times \cancel{90}}{\cancel{45} \times \cancel{12}} = 5 \text{ days, Ans.}$$

380. In practice, the work is somewhat shortened. Since the number of days is required, we write the given number of days last, with a line underneath.

$$\begin{array}{l} 5 \text{ men mow } 45 \text{ acres} \\ 1 \text{ man mows } 1 \text{ acre} \\ 12 \text{ men mow } 90 \text{ acres} \end{array} \left. \begin{array}{l} \text{days.} \\ \left. \begin{array}{l} 6 \times 5 \times 90 \\ 45 \times 12 \end{array} \right. \end{array} \right\}$$

If 5 men do the work in a certain time, 1 man will require 5 times as many days. We place 5 in the numerator (as a multiplier). To

cut 1 acre, he will take $\frac{1}{45}$ of the time required to cut 45 acres. Place 45 in the denominator (as a divisor).

12 men will take $\frac{1}{12}$ of the time 1 man requires. Place 12 in the denominator. To cut 90 acres will require 90 times as long. Place 90 in the numerator.

8. If 12 horses eat 60 bushels of oats in 6 days, how many bushels will 24 horses eat in 3 days?

Make bushels the last term.

$$\begin{array}{rcl} 12 \text{ horses in 6 days eat} & & \text{bu.} \\ 1 \text{ horse in 1 day eats} & & \left. \right\} 60 \\ 24 \text{ horses in 3 days eat} & & \end{array}$$

9. If 24 men use 240 pounds of beef in 2 weeks, how many pounds will 18 men use in 8 weeks?

$$24 \text{ men in 2 weeks use } \underline{240 \text{ lb.}}$$

10. If 6 printers can print 1656 books in 9 days, how many books will 15 printers print in 10 days?

11. How much will it cost to feed 520 sheep for 36 days, if it costs \$128 to feed 160 sheep 48 days?

12. In what time will 8 masons build a wall 84 feet long, working 10 hours a day, if 12 masons build a wall 96 feet long in 8 days, working 8 hours a day?

13. How much money must I lend for 1 year and 3 months, when the rate of interest is 5 per cent, in return for \$60 lent me for 9 months, which I borrowed at 4 per cent?

14. If 27 men build 54 rods of wall in 6 days, how many rods will 32 men build in 9 days?

15. If 50 men can do a piece of work in 90 days, working 8 hours a day, in how many days will 72 men do it, working 10 hours a day?

16. If \$350 earns \$42 interest in 3 years, how much will \$225 earn in 5 years?

17. If a wall 34 feet high could be built by 68 men in 15 days, how many men could build a wall 32 feet high in 8 days?

18. If a ship's crew of 500 men have provisions to serve for 48 days, at the rate of 27 ounces a day for each man, how many men will the same provisions serve for 60 days, allowing each man 30 ounces a day?

19. How many hours a day must 9 men work so that they may do as much in 16 days as 12 men can do in 15 days of 8 hours each?

20. If 30¢ is paid for 6 lb. 14 oz. of bread, when wheat is 85½¢ per bushel, what should be paid for 23 lb. 12 oz., when wheat is 99¢ per bushel?

21. If 3 men can do as much work as 7 boys, how long will it take 28 boys to do as much work as 16 men can do in 24 days?

22. A crew of 16 men have provisions for 36 days, allowing 20 ounces to each man per day. After sailing 10 days they pick up 10 shipwrecked sailors. How long will the provisions then last at the rate of 16 ounces per man?

23. If A can do a piece of work in 4 days, and B can do the same work in 5 days, how many days will it take both, working together?

A can do $\frac{1}{4}$ of the work in one day, and B $\frac{1}{5}$ of it. Together they can do $\frac{1}{4} + \frac{1}{5}$, or $\frac{9}{20}$ in one day. If they do 9 twentieths in one day, to do 20 twentieths, or the whole work, will require $(20 + 9)$ days, or $2\frac{1}{2}$ days.

24. If one man can do a piece of work in 24 days, and another man can do it in 48 days, how long will it take both, working together?

APPROXIMATIONS.

Pupils should be drilled to take a broader view of their work, by estimating the probable result before taking a pencil. In this way many absurd answers might be avoided.

381. Give approximate answers at sight:

1. Find the interest of \$150, at 4%, from Jan. 1, 1903, to Dec. 30, 1905. (Nearly 3 years.)
2. What is the weight, at $57\frac{1}{2}$ lb. per cubic feet, of a cake of ice 4 ft. by 2 ft. by $1\frac{1}{2}$ ft? (Nearly 60 lb. per cubic feet.)
3. Find the amount of goods sold, the commission at $2\frac{1}{8}\%$ being \$11.75. (About 3%).
4. What % of 497 is 249?
5. What % of $3\frac{1}{8}$ is $11\frac{1}{2}$?
6. Cost of 19,987 ft. boards at \$30.05 per M?
7. How much will be paid for 4 barrels sugar, each containing 299 pounds, at $5\frac{1}{16}$ ¢ per pound?
8. $18.0327 + 4.5026$.
9. $83\frac{1}{2}\% + 3\frac{1}{2}\%$.
10. 74 A. 155 sq. rd. land at \$79 per acre?
11. $487\frac{3}{4}$ is what per cent of 960?
12. If 17 bu. 37 lb. of corn cost \$8.75, what will 52 bushels cost?
13. About how many cords of wood in a pile 25 feet long, 4 feet wide, 5 feet high?
14. How many bushels ($1\frac{1}{4}$ cu. ft.) can be placed in a bin 6 feet long, 5 feet wide, 4 feet high?
15. How many acres in a field 52 rods long, 30 rods wide?
16. About how many yards are there in the side of a square field containing 1 acre (4840 square yards)?

REVIEW OF SIMPLE NUMBERS.

382. Written Exercises.

$$\begin{array}{r}
 6748 \\
 \times 427 \\
 \hline
 47236 \\
 283416 \\
 \hline
 2881396
 \end{array}$$

After multiplying by 7, the pupil multiplies this latter product by 6 tens, which gives him the product by 42 tens. In this way one line is saved.

383. Find products:

- | | |
|------------------------|-------------------------|
| 1. $3,925 \times 328$ | 6. $31,265 \times 164$ |
| 2. $12,345 \times 273$ | 7. $5,763 \times 426$ |
| 3. $2,087 \times 287$ | 8. $87,093 \times 486$ |
| 4. $20,308 \times 142$ | 9. $6,905 \times 364$ |
| 5. $4,321 \times 189$ | 10. $64,271 \times 357$ |

$$\begin{array}{r}
 3289 \\
 832 \\
 \hline
 26312 \\
 105248 \\
 \hline
 2736448
 \end{array}$$

First multiply by '800, by placing the first figure of the product by 8 in the hundreds' place. Multiply this by 4, writing the first figure in the units' place.

- | | |
|---|---------------------------------|
| 11. 4008×214 | 16. 6352×927 |
| 12. 8736×742 | 17. 2781×525 |
| 13. 3764×327 | 18. 9060×1166 |
| 14. 1087×848 | 19. 6329×618 |
| 15. 8319×416 | 20. 2345×1272 |
| 21. Multiply 6984 by 25. $\frac{1}{4}$ of 698400. | |
| 22. 4327×75 | |
| 23. $3762 \times 62\frac{1}{2}$. Multiply 876,200 by $\frac{1}{4}$ | |
| 24. $5796 \times 62\frac{1}{2}$ | 27. $7154 \times 87\frac{1}{2}$ |
| 25. $8383 \times 12\frac{1}{2}$ | 28. $6419 \times 33\frac{1}{3}$ |
| 26. $3428 \times 37\frac{1}{2}$ | 29. $6208 \times 66\frac{2}{3}$ |

REVIEW OF FRACTIONS.

384. Written Exercises.

$$\begin{array}{r} 7854 \times \frac{3}{4} \\ 1963\frac{1}{2} \text{ Deduct } \frac{1}{2} \\ \hline 5890\frac{1}{2} \text{ Ans.} \end{array}$$

$$\begin{array}{r} 9365 \times \frac{7}{8} \\ 1170\frac{5}{8} \text{ Deduct } \frac{1}{8} \\ \hline 8194\frac{3}{8} \text{ Ans.} \end{array}$$

Multiply 6578 by 9 $\frac{2}{3}$.

$$\begin{array}{l} 65,780 = 10 \text{ times number.} \\ 2,192\frac{2}{3} = \frac{1}{3} \text{ number (deduct).} \\ \hline 63,587\frac{1}{3} \text{ Ans.} \end{array}$$

385. Find products:

- | | |
|---------------------------------|---------------------------------|
| 1. 176 $\times \frac{15}{8}$ | 11. 4844 $\times 9\frac{1}{2}$ |
| 2. 273 $\times \frac{11}{8}$ | 12. 8960 $\times 8\frac{7}{8}$ |
| 3. 4554 $\times \frac{5}{8}$ | 13. 3245 $\times 7\frac{1}{2}$ |
| 4. 1001 $\times \frac{10}{8}$ | 14. 9060 $\times 11\frac{1}{2}$ |
| 5. 3243 $\times \frac{3}{8}$ | 15. 658 $\times 99\frac{1}{4}$ |
| 6. 6776 $\times \frac{5}{8}$ | 16. 658 $\times 99\frac{1}{4}$ |
| 7. 2307 $\times \frac{9}{8}$ | 17. 725 $\times 119\frac{1}{4}$ |
| 8. 7284 $\times \frac{7}{8}$ | 18. 347 $\times 79\frac{5}{8}$ |
| 9. 5631 $\times \frac{9}{16}$ | 19. 418 $\times 89\frac{1}{4}$ |
| 10. 9657 $\times \frac{11}{12}$ | 20. 543 $\times 49\frac{1}{4}$ |

386. Written Exercises.

NOTE.—Do not use too many figures.

1. Add $\frac{4}{5}, 2\frac{1}{4}, \frac{2}{7}, \frac{5}{8}$.

2. Divide each of the following fractions by 6:

$$\frac{5}{7}, \frac{12}{13}, \frac{25}{48}, \frac{84}{108}.$$

3. Reduce $\frac{7}{8}$ of $\frac{6}{11}$ of $\frac{5}{12}$ of $2\frac{1}{2}$ to a simple fraction.

4. $38\frac{5}{8} - 21\frac{9}{10}.$ $40\frac{3}{8} - 18\frac{7}{9}$

5. What fraction of £1 18s. 9d. is 5s. 6d.?
6. Multiply $24\frac{1}{2}$ by $\frac{2}{3}$ of $\frac{3}{4}$.
7. What is the greatest common divisor of 657 and 1168? the least common multiple of 12, 16, 20, 30?
8. What must be taken from $8\frac{5}{16}$ to leave $3\frac{7}{12}$?
9. Reduce $\frac{4\frac{1}{2}}{2\frac{1}{2}}$ and $\frac{4\frac{1}{2}}{3\frac{1}{2}}$ to their lowest terms.
10. Which is the greatest and which is the least, $\frac{1}{2}$ of $\frac{2}{3}$, $\frac{2}{3}$ of $\frac{1}{2}$, and $2\frac{1}{2}$ of $1\frac{1}{2}$?
11. What must be added to $3\frac{4}{11}$ to make $5\frac{1}{4}$?
12. Add $\frac{2}{3}$ of a week, $\frac{2}{3}$ of an hour, $\frac{7}{12}$ of a minute.
13. How much is 9 times each of the following fractions?
 $\frac{6}{5}, \frac{6}{11}, \frac{7}{27}, \frac{1}{8}$.
14. $30\frac{1}{2} + \frac{2}{3}$ of 7.
15. $\frac{7}{12} + \frac{2}{3}$ of $\frac{1}{10} + \frac{2}{3}$ of $\frac{2}{3}$.
16. What part of a 10-acre field is 4 A. 100 sq. rd.?
17. What is the least number that will contain each of the numbers 6, 15, 18, and 20?
18. What must be multiplied by $4\frac{1}{2}$ to produce $16\frac{1}{4}$?
19. What is the value of $\frac{\frac{1}{2} + \frac{2}{3}}{4\frac{1}{4}}$?
20. What quantity must be divided by $4\frac{1}{2}$ to produce $8\frac{1}{2}$?
21. Find the value of $\frac{2\frac{1}{4} + \frac{2}{3}}{4\frac{1}{2} - \frac{5}{6}}$.
22. How much is $\frac{\frac{1}{2} - \frac{2}{3}}{2\frac{1}{2}}$ of 3 da. 15 hr. 32 min.?
23. Reduce $\frac{4}{15}$ mile to rods.
24. Add $\frac{2}{3}, \frac{2}{3}, 5\frac{1}{2}$. Subtract $4\frac{5}{12}$ from the sum.
25. Multiply $\frac{2}{3}$ of $5\frac{1}{2}$ by $7\frac{1}{2}$. Divide the result by $1\frac{1}{2}$.

REVIEW OF DECIMALS.**387. Written Exercises.**

1. Express as decimals $\frac{57}{100}$, $\frac{7}{1000}$, and $\frac{37}{1000}$.
2. $.395 + 86.7 + 209.0043 + .81 + 3.075 + 27$.
3. Divide 34,020.072 by 5.309. $570 \div .005 = ?$
4. Multiply 80.037 by 10. Seventy-three hundred-thousandths by one hundred. $.2054 \times 1000 = ?$
5. Subtract 48.8067 from 53.07. $.0539 \times 26.08 = ?$
6. The smaller of two numbers is 8.5307, and their sum is 25.07. Find the larger number.
7. Express .39, 6.175, .00036, and 74.0005 as common fractions (or mixed numbers).
8. Divide .826 by 100; 543.71 by 10,000; and fifty-nine ten-thousandths by one thousand.
9. Find the difference between 9.84 and 38.005, and the continued product of 83.09, .734, and 5.007.
10. Reduce 6 shillings 9 pence to the decimal of a pound sterling.
11. Express as decimals seven hundredths, forty-three ten-thousandths, and ninety-one millionths.
12. Change $\frac{1}{16}$, $8\frac{1}{80}$, $\frac{1}{125}$, and $\frac{1}{256}$ into decimals. Find their sum.
13. Express .42796 as a common fraction, and the sum of $\frac{7}{10}$, $\frac{8}{100}$, and $\frac{373}{1000}$ as a decimal.
14. $3.009 \times .07 \times .0907$.
15. Divide .0075 by .15, and .00044408 by .0112.
16. Divisor, 403.6; quotient, 2.709. Dividend?
17. What is the value of $\frac{.035 \times .0056}{.00007}$?
18. Change 69 rods to the decimal of a mile.
19. Change .4285 month (30 days) to days, hours, etc.

SPECIAL DRILLS.

388. Give sums:

$$1. \quad 856 + 256 = 856 + 200 + 50 + 6$$

The pupil says (or thinks) only 1056, 1106, 1112.

$$2. \quad 576 + 425 \qquad 4. \quad 749 + 312 \qquad 6. \quad \$6.73 + \$3.94$$

$$3. \quad 685 + 599 \qquad 5. \quad 567 + 658 \qquad 7. \quad \$8.27 + \$4.89$$

Give remainders:

$$8. \quad 1244 - 655 = 1244 - 600 - 50 - 5$$

Think only 644, 594, 589.

$$9. \quad 1021 - 576 \qquad 11. \quad 1040 - 312 \qquad 13. \quad \$12.00 - \$8.73$$

$$10. \quad 1264 - 685 \qquad 12. \quad 1322 - 643 \qquad 14. \quad \$11.05 - \$2.69$$

Give products:

$$15. \quad 24 \times 21 = 20 \text{ times } 24 + 24 = 480 + 24$$

Say only 480, 504.

$$16. \quad 33 \times 21 \qquad 18. \quad 41 \times 41 \qquad 20. \quad 31 \times 31$$

$$17. \quad 22 \times 31 \qquad 19. \quad 32 \times 41 \qquad 21. \quad 44 \times 21$$

Give sums:

$$22. \quad 425 + 99 = 425 + 100 - 1$$

Say only 525, 524.

$$23. \quad 576 + 99 \qquad 24. \quad 999 + 425 \qquad 25. \quad \$8.68 + \$4.99$$

Give remainders:

$$26. \quad 565 - 99 = 565 - 100 + 1$$

Say only 465, 466.

$$27. \quad 743 - 99 \qquad 28. \quad 1230 - 999 \qquad 29. \quad \$12.13 - \$4.99$$

Give products:

$$30. \quad 27 \times 99 = 100 \text{ times } 27 - 27 = 2700 - 27$$

$$31. \quad 36 \times 99 \qquad 32. \quad 24 \times 99 \qquad 33. \quad 98 \times 99$$

389. Oral Review Problems.

1. What will be the cost of 48 yards of cloth at $87\frac{1}{4}\text{\$}$ per yard?
2. A horse was sold for \$80, which was $\frac{1}{3}$ of the cost. How much was lost on the horse?
3. How many yards of carpet 27 inches wide will be needed to cover a floor containing 48 square yards?
4. Paid \$3.45 for groceries, \$1.50 for dry goods, and 99¢ for sundries. What is the total?
5. From a chest containing $25\frac{1}{4}$ pounds of tea, $8\frac{1}{2}$ pounds were sold. How many pounds remain?
6. What would be the cost of 2 bushels blueberries at 5¢ per quart?
7. $83\frac{1}{4}$ yards of cloth are divided into 9 pieces. How many yards are there in each piece?
8. I buy hardware to the amount of \$6.37. I give the storekeeper two \$5 bills. How much change should I receive?
9. What will be the cost of 24 yards of calico at $4\frac{1}{4}\text{\$}$ per yard?
10. What should I pay for 19 baseballs at \$1.25 each?
11. At $1.87\frac{1}{2}$ per yard, what will be the cost of 120 yards of silk?
12. For \$120, how many yards of silk can I buy at $1.87\frac{1}{2}$ per yard?
13. What is the interest of \$300, for 30 days, at 6 per cent?
14. What will 18 oranges cost at 35¢ per dozen?
15. At $4\frac{1}{4}\text{\$}$ per yard, how many yards of calico can I buy for 95¢?

16. How many square yards are there in a field 41 yards long, 42 yards wide ?
17. If I pay 15¢ for $3\frac{1}{2}$ yards of muslin, what is the price per yard ?
18. How many acres of land are there in two farms containing, respectively, 347 and 495 acres ?
19. At $87\frac{1}{2}$ ¢ each, how many baseballs can be bought for \$ 56 ?
20. How much will be paid for 21 pounds butter, at 28¢ per pound ?
21. Paid 23¢ for calico, 27¢ for ribbon, and 48¢ for collars. What was the amount of my bill ?
22. A farmer had 95 sheep. He sold 39, and 17 died. How many had he left ?
23. What will be the cost of 16 baseballs, at 49¢ each ?
24. How much paint will there be in 27 casks, each containing 75 pounds ?
25. A man divided a 429-acre farm into plots of 13 acres each. How many such plots were there ?
26. There are 900 men in a certain regiment. How many companies of 75 men each are in the regiment ?
27. Find the cost of 136 pounds sal-soda, at $\frac{7}{8}$ ¢ per lb.
28. At $19\frac{1}{2}$ ¢ per yard, what will be paid for 64 yards gingham ?
29. How many square inches in a sheet of paper $10\frac{1}{2}$ inches long by $4\frac{1}{2}$ inches wide ?
30. If $2\frac{1}{2}$ yards of cloth are needed for a jacket, how many jackets can be made from $18\frac{1}{2}$ yards ?
31. How many yards around a field 96 yards long, 75 yards wide ?

32. What will be the area, in square rods, of a triangle 33 rods base, altitude 42 rods?
33. How many acres in 4960 square rods?
34. How many feet in a mile?
35. I paid \$16.25 for cloth at \$1.25 per yard. How many yards did I buy?
36. Half a number + $\frac{1}{2}$ of the same number = 85. What is the number?
37. I mix 4 pounds of coffee costing 20¢, with 6 pounds costing 25¢. What is the mixture worth per pound?
38. A tailor makes up 99 yards of cloth into trousers, using $2\frac{3}{4}$ yards per pair. How many pairs of trousers does he make?
39. At 60¢ per pound, what will be the cost of a chest of tea weighing 45 pounds?
40. A man owns a strip of land with a frontage of 576 feet. How many lots 18 feet front can he make?
41. A can do a piece of work in 5 hours, B in 7 hours. How long will it take both working together?
42. At what rate will \$300 gain \$24 in 2 years?
43. What sum of money will gain \$30, in 2 yr. 6 mo., at 6%?
44. If a staff 12 feet long casts a shadow of 3 feet, what is the length of a pole that casts a shadow of 27 feet at the same time?
45. If 20 men can perform a piece of work in 8 days, how many men will it take to do the same work in 5 days?
46. An agent receives \$8200 to invest after deducting his commission of $\frac{1}{10}$ of the amount invested. What is the agent's commission?
47. A lot is sold for \$1200, at a loss of 20 per cent. What part of \$1200 is the loss?

390. Written Problems.

1. A rug costs \$20. It is sold at a profit of 20%. The selling price is 20% below the marked price. How much is received for the rug? What is the marked price?
2. What price must cloth, which cost \$2 per yard, be marked so that a profit of 20% will be made when the cloth is sold at 20% less than the marked price?
3. A coal bin is 6 feet long and 4 feet wide. How deep must it be to contain 5 tons of stove coal, if one ton occupies 36 cubic feet of space?
4. A man walking at the rate of 3 mi. 96 rd. per hour will walk how far in 3 hr. 16 min.?
5. If a merchant pays $6\frac{1}{4}$ ¢ per yard for muslin, and sells the same for $7\frac{1}{4}$ ¢ per yard, what is his gain per cent?
6. Make and solve a problem illustrating the application of percentage to the finding of an agent's commission.
7. Multiply eight hundred (units) and forty-six ten-thousandths by three thousand forty millionths.
8. What is the interest on \$128.40, for 1 yr. 5 mo. 17 da. at 6 per cent?
9. A regiment of 940 men, during the war, lost 532 of their number by death and 125 by desertion. What was the percentage of loss in each case, and what per cent remained for service?
10. A merchant sold a lot of damaged sugar at a loss of 25 per cent, receiving \$1972.65. How much did the sugar cost him?
11. What is a pile of wood 15 feet long, $10\frac{1}{2}$ feet high, and 12 feet wide worth, at \$4 $\frac{1}{2}$ per cord?
(1 cord = 128 cu. ft.)
12. Add the greatest and the least of the three fractions $\frac{17}{16}$, $\frac{6}{7}$, $\frac{11}{8}$; and divide the sum by the remaining fraction.

13. Multiply 82 ten-thousandths by 7 and 5 hundredths, and divide the product by 705 millionths.

14. Find the cost of 96 feet of pine lumber at \$25 per M, and 1650 laths at \$3 per M.

15. A horse costing \$160 is sold for \$180. What is the gain per cent? What is the loss per cent when a horse costing \$180 is sold for \$160?

16. A merchant sold 600 barrels of flour for \$3450, at a loss of $4\frac{1}{2}$ per cent. What did the flour cost him per barrel?

17. How long would it take a person to count a million silver dollars, at the rate of 100 a minute, and working 8 hours a day?

18. Find the number of days from March 2, 1903, to August 11, 1903.

19. Find the interest on a note for \$250, dated Jan. 21, 1904, and paid May 30, 1904, at 6%.

20. Divide 22.5 by 51.75, and express the result in the form of a fraction.

21. By the census of 1890, the population of a certain city was 26,275. By the census of 1900, its population was 31,530. Find the per cent of increase.

22. Each of two boys bought 100 apples for a dollar. The first boy sold his, 4 apples for 5¢; the second sold his, 5 apples for 6¢. Which boy gains the more per cent? How much more?

23. A quantity of coal was bought for \$900. For what must it be sold to gain $33\frac{1}{3}\%$?

24. By selling a house for \$5760, a man gained on the cost 25%. What was the cost?

25. Change to other methods of expression, $\frac{1}{4}$, $\frac{1}{3}$, .37 $\frac{1}{2}$, $\frac{5}{4}$, .16 $\frac{2}{3}$.

26. A note of \$ 1260, dated July 5, 1904, was paid June 7, 1906, with interest at 8%. What was the amount paid?
27. A flock of sheep has been increased by 250% of its number, and now numbers 1050. What was the original number?
28. Bought a house for \$ 6240, and sold it so as to gain 35%. What did I sell it for?
29. Sold goods at a loss of 20%, an actual loss of \$ 57.50. What was the first cost?
30. The milk from a herd of 25 Jersey cows, sold at 6¢ a quart, amounted in one summer to \$2025. How many quarts were sold, and what was the average quantity from each cow?
31. A woman has three children. She pays for each \$ 15 a year for having his clothes made, \$ 1.50 a month for his mending, and \$ 0.35 a week for his washing. How much could she save in a year if she knew how to wash, make clothes, and mend?
32. A farmer exchanged 340 bushels of corn worth 75¢ per bushel, for barley worth \$1 per bushel, and oats worth 50¢ per bushel. How many bushels of each did he receive, the quantity of barley and oats being equal?
33. A pole stands $\frac{1}{4}$ in the mud, $\frac{2}{3}$ in the water, and 32 ft. in the air. How long is the pole?
34. Bought flour for \$ 8.25, and sold it for \$ 9. What is the per cent of gain?
35. Bought flour for \$ 9 and sold it for \$ 8.25. What is the per cent of loss?
36. If two-thirds of a yard of silk can be bought for $\$ \frac{1}{4}$, how many yards can be bought for $\$ 3\frac{1}{2}$?
37. A drover sold 250 sheep for \$1150, which was 15% more than they cost. What was the cost of each sheep?

38. Find a common divisor of 72 and 90.
39. How many feet of paper, 18 inches wide, will paper the sides of a room 16 feet by 14 feet, and 10 feet high, deducting 174 square feet for doors and windows?
40. Find the sum of $\frac{3}{50}$, $\frac{2}{7}$, $\frac{4}{5} \frac{3}{8}$, $\frac{7}{24}$, $\frac{7}{48} \frac{5}{6}$, in decimals, correct to fourth place.
41. The dividend is 9876, the quotient is 87, the remainder is 45. Find the divisor.
42. Change .03125 to a common fraction in smallest terms.
43. Bought a hogshead of sugar containing 848 pounds for \$38.16, and paid \$4.24 freight and cartage. At what price per pound must it be sold to gain 20%?
44. To $\frac{3}{5}$ of $\frac{3}{4}$ add $\frac{1}{2}$ of $\frac{7}{16}$, and reduce to lowest terms; multiply the sum so obtained by $1\frac{1}{2}$, and reduce to a mixed number; from the product subtract $\frac{5}{6}$, and reduce to lowest terms; divide the remainder by 5, and convert the quotient into a decimal fraction; add 1.1; multiply by 2.5; subtract .9; and divide the remainder by .007.
45. A can weigh a certain quantity of goods in 15 days by working 7 hours a day. How long will it take him to do the same work by working 9 hours a day?
46. In an example in division the remainder is 14, the divisor is 16, and the quotient is 18. What is the dividend?
47. Solve by cancellation:
How many pieces of cotton cloth, each piece containing 42 yards, at $9\frac{1}{2}\text{¢}$ per yard, can be bought for 14 firkins of butter, each containing 56 pounds, at 19¢ per pound?
48. What must be the depth of a bin which is 4 ft. wide and 6 ft. long, to contain 40 bushels oats?
49. A farmer sold 9875 pounds hay at $\$12\frac{1}{2}$ per ton, and took in part payment 5000 feet of boards at \$11 per thousand. How much remained due him?

50. Bought 80 barrels of flour at \$6 per barrel, paying for freight \$30. At what price must I sell it per barrel to gain 30% on the total cost?

51. What is the amount of \$720.50, for 3 yr. 5 mo. 19 da., at 6 per cent?

52. Three men buy a house for \$2500. A pays \$500, B pays \$900, C pays \$1100. They rent it for \$250. What is each one's share of the rent?

53. If 12.875 acres of land cost \$1030, what will 4.75 acres cost?

54. Write three-fourths of one per cent, first as a pure decimal, and again as a common fraction.

55. If a man paid \$18 $\frac{3}{4}$ for a load of hay weighing 1 $\frac{1}{2}$ tons, what would he pay at the same rate for $\frac{3}{4}$ of a ton?

56. If 11 weavers in 9 days weave 1584 yards, what will 1 man do in 1 day? 6 men in 7 days?

57. What is the exact interest of \$500, for 100 days, at 8 per cent? (Take 365 days to the year.)

58. Divide the product of $8\frac{1}{4}$ and $11\frac{1}{2}$ by their difference.

59. A merchant bought 340 bushels of potatoes at 80¢ per bushel; 20 per cent of them proved worthless, and were thrown away. He sold the remainder at \$1.10 a bushel. What did he gain or lose?

60. Divide eighty-four and eighty-four hundredths by forty-eight thousandths.

61. How much money in silver dollars, $412\frac{1}{2}$ grains each, will weigh 165 pounds Avoirdupois, 7000 grains to the pound?

62. What is the amount of \$1395, at 4 per cent, for 7 mo. 24 da.

63. A coal dealer buys 150 tons of coal, 2240 pounds each, at \$4.50 per ton. He sells it at \$4.75 per ton, giving 2000 pounds to the ton. What is his profit?

64. What is the value of $(\frac{2}{3} \text{ of } \frac{5}{6} \text{ of } 3\frac{1}{4} + 8\frac{1}{2}) + (10\frac{1}{2} - 7\frac{1}{4})$?
65. How many bushels of grain will fill a bin 8.5 feet long, 4.25 feet wide, and $3\frac{1}{4}$ feet deep?
66. Three workmen receive \$283.50 for doing a piece of work. One worked 32 days, the second worked 53 days, the third worked 41 days. What is the share of each?
67. A man bought silverware for \$120, and sold it for \$250 less $33\frac{1}{3}$ and 10 per cent. What was his profit per cent?
68. What is the interest on \$356.75, at 4 per cent, for 3 yr. 5 mo. 14 da.?
69. A note for \$600, drawn Jan. 16, payable 4 months after date, is discounted March 25 at a bank, at 6 per cent. What are the proceeds?
70. A dry-goods merchant sells goods $12\frac{1}{2}\%$ per yard more than their cost, and realizes a profit of 8 per cent. What is the cost per yard?
71. A man bought 396 acres of land for \$40,293. He sold 150 acres at \$120 per acre, 134 acres at \$80 per acre, and the remainder at cost. Did he gain or lose, and how much?
72. If $44\frac{2}{9}$ yards of calico cost \$1.99, how much must be paid for 80 yards?
73. Divide the sum of 75 thousandths and 75 ten-thousandths by the difference between 75 hundredths and 75 tenths.
74. What number divided by 320 gives 47 for quotient and 163 for remainder?
75. In a schoolroom there are 35 pupils and a teacher. The room is 30 feet long, 20 feet wide, and 15 feet high. How many cubic feet of air space has each person?
76. A merchant sold a quantity of flour for \$282, losing 6 per cent. How much money did he lose?

77. I bought 2500 bushels of wheat at 80¢ per bushel, and sold it for 84¢ per bushel, on a note for 60 days, which I had discounted immediately at a bank, at 6%. How much did I gain?

78. A merchant bought 84 yards of linen at 55¢ per yard, and 105 yards of muslin at 20¢ per yard. He sold all the linen at 40¢ per yard. What must he charge per yard for the muslin in order to make up exactly his loss on the linen?

79. A fruit dealer bought a lot of oranges for \$240. He sold $\frac{1}{2}$ of them for $\frac{1}{2}$ of the entire cost; $\frac{1}{2}$ of the remainder for $\frac{2}{3}$ of the entire cost; $\frac{1}{2}$ of what then remained for $\frac{1}{6}$ of the entire cost; and the final remainder for $\frac{1}{3}$ of the entire cost. What was his gain or loss?

80. The owner of 165 shares of gas stock sold them at \$25 per share, and with the proceeds purchased two lots, 32 feet by 115 feet, and 30 feet by 105 feet, respectively, and had just \$27 left. What was the price per square foot of the lots?

81. A man purchased a house, paying for it in four payments as follows: on the first payment $\frac{1}{2}$ of the purchase price; on the second payment $\frac{1}{2}$ of the remainder; on the third payment $\frac{1}{2}$ of what then remained due; and on the last payment \$2000. What was the full amount paid for the house?

82. Find the difference between the greatest common divisor of 480 and 520, and the least common multiple of 5, 6, 15, and 20.

83. Find the value of a pile of wood 40 feet long, 8 feet wide, and 4 ft. 6 in. high, at \$5.50 a cord.

84. A cargo of flour was bought for \$690. For what must it be sold to gain $66\frac{2}{3}\%$?

85. Find the sum of all the prime numbers to 50.

86. If A and B can mow a field in seven days, and A, B, and C mow it in five days, for \$25, what ought C to receive?

87. To $\frac{4}{5}$ of a score add $\frac{4}{5}$ of a dozen, and from the sum subtract $\frac{2}{5}$ of a hundred. What is the remainder?

88. What must be the length of a load of wood that is 4 feet wide and $5\frac{1}{3}$ feet high to contain 2 cords?

89. Bought a hogshead of molasses containing 128 gallons, at 65¢ a gallon; paid 80¢ for cartage, and lost 16 gallons by leakage. At what price per gallon must the remainder be sold to gain one-fifth of the entire cost?

90. What is the least number that will exactly contain 48, 20, 21, 24?

91. Sold 50 sofas for \$2250. 25 of them were sold at a gain of 20 per cent, and 25 at a loss of 20 per cent. What was the gain or loss on the transaction?

92. Bought a number of eggs, and sold 11 of them for what 18 cost me. What was my gain per cent?

93. A bookseller wishes to mark up the price of a book which he is now selling for \$2, so that he can deduct 15 per cent, and yet receive the present price. What must be the marked price?

94. What is the difference between .75 divided by 75, and 75 divided by .75?

95. A watch that loses 35 seconds in an hour was set right at noon on Monday. What time did it show at 6 P.M. the following Thursday?

96. Mr. A. sold a horse for \$240, which was 20 per cent less than he asked for it, and his asking price was 20 per cent more than the horse cost him. What was the cost of the horse?

97. Three quarts dry measure is what per cent of a bushel?

98. What will it cost to carpet an office room measuring 21 feet in length, and 18 feet in width, the carpeting being $\frac{4}{5}$ yard wide, and costing \$1.35 per lineal yard?

99. A physician accepts, in payment of a bill, a note for \$275.75, due in one year and three months, with interest at 7 per cent. What amount will be due at maturity?

100. At what rate will \$1500 amount to \$1684.50, in 2 yr. 18 da.?

101. How shall I mark goods that cost me \$.96 a yard, in order to abate 15% and still make 15%?

102. What will it cost to insure a factory valued at \$21,000, at $\frac{1}{2}\%$, and the machinery valued at \$15,400, at $\frac{1}{8}\%$?

103. In what time will \$750 gain \$195 interest, at 4%?

104. What is the rate per cent when the amount of \$500 is \$593.75, for 2 yr. and 6 mo.?

105. What principal will gain \$360 in 5 yr. 4 mo., at $4\frac{1}{2}\%$?

106. Bought 480 barrels of flour, at \$4.50 a barrel, and sold it for \$2880. Find the gain per cent.

107. By selling a house for \$10,304, a man gained 15% on the cost. What was the cost?

108. A man, dying, left $\frac{1}{2}$ of his estate to his wife, $\frac{1}{3}$ of the remainder to his son, and the remainder to his daughter, who received \$5000. What was the value of the estate, and what was the son's share?

109. What is the interest of \$10, for 10 yr. 10 mo. 10 da., at 10 per cent?

110. If it takes one man $7\frac{1}{4}$ days to do a piece of work, how long will it take 3 men to do $2\frac{1}{2}$ times as much?

111. A grocer pays 18¢ per pound for coffee, and roasts it, losing 10% of the weight in the process. What must he charge per pound for the roasted coffee in order to make a profit of 20%?

112. A merchant bought 48 bales of cotton, and then sold the lot for \$2008.80, losing 7%. What was the cost per bale?

113. What is the cost of sawing a pile of wood 20 feet long, 4 feet wide, and 6 feet high, at \$1.20 a cord?

114. After increasing the wages of his workmen $33\frac{1}{3}\%$, a manufacturer paid them \$2.60 a day. What did he pay them before?

115. What should a bookseller charge for a book for which he paid at the rate of \$54 a dozen, that he may make 20% on the cost?

116. What is the per cent profit or loss when a hundred logs which cost \$65 are sold at 78¢ each?

117. A man spent $\frac{8}{11}$, and invested in his business $\frac{4}{15}$, of his income. He deposited the remainder, \$1850, in a bank. What was his income?

118. Sold a horse for \$322, and thereby lost 8%. What should I have sold it for to gain 15%?

119. Bought a horse for \$340; paid \$60 for keeping him, and then sold him for \$540. What per cent was gained?

120. John bought $12\frac{1}{2}$ pounds of sugar at $5\frac{1}{2}$ ¢ a pound, spending 25% of his money. How much had he at first?

121. When 10.25 bushels of wheat cost \$12.71, what will $7\frac{1}{2}$ bushels cost?

122. Mr. Jones paid \$15.12 for the use of a sum of money for 1 yr. 6 mo., at 5%. What was the sum?

123. What were the proceeds of a note for \$725.14, due July 7, discounted at a bank June 20, at 8%?

124. After Mr. Jones had spent $37\frac{1}{2}\%$ of his money, he found that he then had enough to buy 80 pounds of rice at $6\frac{1}{2}$ ¢ a pound. How much could he have bought with the whole of his money?

125. On the 10th day of November, 1899, you lent William Rogers \$864.50. How much does he owe you today, the rate of interest being $4\frac{1}{2}\%$?

126. A man bought wheat for \$10,867, and sold it at a gain of $4\frac{1}{2}\%$. What did he receive for it?

127. Divide three million by six thousand, and multiply the quotient by .024.

128. How much must I have invested at 5% that my income may be \$2880 per year?

129. Add these *across*, placing the totals in the space indicated; then add the totals:

Totals.						
14,305	10,702	18,346	37,946	43,865	17,387	
22,324	17,437	18,438	3,741	22,972	25,960	
13,849	67,431	34,965	12,674	32,905	1,468	
15,607	27,865	32,476	18,430	33,301	18,695	
19,898	13,460	27,686	23,492	13,852	26,973	

130. If 1998, or 27 per cent, of the inhabitants of a town are voters, how many inhabitants has the town?

131. Ten cows were sold for \$690, at a gain of 15 per cent. For how much per head on the average should they have been sold to gain 20 per cent?

132. Find the interest of \$575.50, for 1 yr. 10 mo. 15 da., at 5%.

CHAPTER VI.

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RATIO.

391. *Ratio* is the relation which one number has to another of the same kind.

The sign of ratio is the colon (:) .

The ratio of 3 to 6 is expressed $3 : 6$.

The colon (:) is the sign used in France and Germany to indicate division as well as ratio.

392. The *terms* of the ratio are the numbers compared, the first being called the *antecedent*, and the second the *consequent*. Both terms constitute a *couplet*.

The ratio of 3 to 6 is obtained by dividing the antecedent by the consequent; 3 : 6 means $\frac{3}{6}$, which is equal to $\frac{1}{2}$.

393. Oral Exercises.

Find the ratio of:

1. 175 to 700. $\frac{175}{700} = \frac{1}{4}$. *Ans.*

2. \$36.50 to \$18.25. $\frac{\$36.50}{\$18.25} = 2$. *Ans.*

NOTE. — The quotient is abstract.

3. 6 pecks to 5 bushels. $\frac{6 \text{ pecks}}{20 \text{ pecks}} = \frac{3}{10}$. *Ans.*

NOTE. — The antecedent and the consequent must be like numbers.

4. \$19 to \$95. 6. 7 tenths to 3 fifths.

5. 20 mills to 1 dollar. 7. 3 quarts to 4 gallons.

8. 1 gallon to 500 cubic inches.

394. Written Problems.

1. One line is 3 rd. 4 yd. long; the length of another is 5 rd. 1 ft. Find the ratio of the first to the second.

The antecedent 3 rd. 4 yd. is to be divided by the consequent 5 yd. 1 ft. As the divisor and the dividend must be like numbers, both terms of the couplet are reduced to feet. The $\frac{3 \text{ rd. } 4 \text{ yd.}}{5 \text{ rd. } 1 \text{ ft.}} = \frac{61\frac{1}{2} \text{ ft.}}{83\frac{1}{2} \text{ ft.}} = \frac{123}{167}$. *Ans.* division is indicated by writing the antecedent above the

consequent as a fraction. The concrete fraction $\frac{61\frac{1}{2} \text{ ft.}}{83\frac{1}{2} \text{ ft.}}$ is changed to the abstract complex fraction $\frac{61\frac{1}{2}}{83\frac{1}{2}}$, which is reduced to a simple fraction by multiplying both terms by 2, giving $\frac{123}{167}$ for the result.

Make the antecedent and the consequent like numbers, and divide the former by the latter.

Chapter Six.

2. M walks in 1 hr. 47 min. as far as N walks in 2 hr. 3 min. What is the ratio of M's speed to N's?

In this example is required the ratio of M's *speed* to N's. The antecedent is, therefore, M's speed, and the consequent is N's speed. As the distance walked is not given, x may be used to represent the number of feet or yards or miles walked by M in 107 minutes, and by N in 123 minutes. $\frac{x}{107}$ will represent the distance walked by M in 1 minute, or M's speed, and $\frac{x}{123}$, N's speed. The ratio of M's speed to N's will be $\frac{x}{107} : \frac{x}{123}$, or $\frac{123}{107} \times \frac{x}{x}$. Cancelling x in each, the result is $\frac{123}{107}$, or $1\frac{16}{107}$. *Ans.*

3. One candle lasts 4 hr. 20 min.; another lasts 3 hr. 15 min. Find the ratio of the first to the second.

4. A pound of coffee costs $25\frac{7}{8}\%$; 1 pound of sugar costs $5\frac{8}{16}\%$. What is the ratio of price of sugar to that of coffee?

5. P earns in $19\frac{1}{4}$ days as much as Q in $18\frac{3}{4}$ days. What is the ratio of Q's daily earnings to P's? Of P's to Q's?

6. One wheel makes 600 revolutions in $8\frac{1}{2}$ seconds; a second makes 300 revolutions in $3\frac{1}{2}$ seconds. What is the ratio of the speed of the first wheel to that of the second?

7. The circumference of a circle is 12.5664 feet, and its radius is 2 feet. What is the ratio of the diameter to the circumference?

8. One train goes 40 miles in 50 minutes; another goes 24 miles in a half hour. What is the ratio of the speed of the second to that of the first?

Find the number of miles each goes in an hour.

9. One window is 6 ft. 8 in. by 4 ft. 2 in.; a second is 4 ft. 8 in. by 2 ft. 1 in. What is the ratio of the area of the second to that of the first?

$$(4\frac{1}{2} \times 2\frac{1}{2}) : (6\frac{2}{3} \times 4\frac{1}{3})$$

10. A mother is now 35 years old, and her son is 3 years and 6 months old. Fourteen months ago what was the ratio of the mother's age to that of her son?

11. A farm costing \$4750 was sold for \$5750. What is the ratio between the profit and the cost?

12. A man can do a piece of work in $4\frac{1}{2}$ days. What part of it can he do in a day and a half? What decimal? What per cent?

13. What is the ratio between a ton of 2000 pounds and one of 2240 pounds?

395. Oral Problems.

1. One line is a rod long; another is $5\frac{1}{2}$ ft. long. What is the ratio of the first to the second?

2. What is the ratio of 7 hours to one day?

3. A pound of coffee costs 30¢, of sugar 6¢. What is the ratio of their respective prices?

4. A walks in 4 hours as far as B in 5. What is the ratio of A's speed to B's?

5. E earns in 6 days as much as D earns in 8 days. Find the ratio of E's daily earnings to D's.

6. One wheel makes 300 revolutions in 2 minutes; the second requires only $1\frac{1}{2}$ minutes to make the same number. Find the ratio of the number of revolutions made by the first wheel in 1 minute to the number made by the second wheel in the same time.

7. A circle whose diameter is 1 foot has a circumference of $3\frac{1}{4}$ feet. What is the ratio of the diameter to the circumference?

8. One train goes 40 miles an hour; a second goes 45 miles an hour. What is the ratio of the speed of the first to that of the second?

PROPORTION.

396. Preliminary Exercises.

1. $\frac{3}{16} = \frac{?}{64}$.

6. $\frac{17}{21} = \frac{51}{?}$.

2. $\frac{18}{37} = \frac{36}{?}$.

7. $\frac{18}{?} = \frac{36}{70}$.

3. $\frac{15}{13} = \frac{?}{65}$.

8. $\frac{?}{24} = \frac{57}{72}$.

4. $\frac{1 \text{ pk.}}{3 \text{ bu.}} = \frac{\$?}{\$ 24}$.

9. $\frac{\$ 16}{?} = \frac{7 \text{ marks}}{21 \text{ marks}}$.

5. $\frac{3 \text{ qt.}}{1 \text{ gal.}} = \frac{30 \cancel{\$}}{? \cancel{\$}}$.

10. $5 + 22 = ? + 88$.

11. $6 \text{ horses} + ? \text{ horses} = \$ 600 + \$ 900$.

12. $1 \text{ ft.} \div ? \text{ yd.} = 15 \cancel{\$} \div 90 \cancel{\$}$.

13. $1 \text{ qt. } 1 \text{ pt.} \div 1 \text{ pt.} = ? \cancel{\$} \div 4 \cancel{\$}$.

14. $1\frac{1}{4} \div \frac{3}{4} = \frac{?}{8} \div \frac{6}{8}$.

15. $2.8 \div .4 = .14 \div x$.

397. Two equal ratios form a proportion.

The ratio of 3 to 9 is $\frac{1}{3}$, which is also the ratio of 13 to 39. This may be expressed $\frac{3}{9} = \frac{13}{39}$, or $3 : 9 = 13 : 39$. Substituting a double colon (:) for the sign of equality (=), we have the following proportion:

$$3 : 9 :: 13 : 39.$$

This is read, 3 is to 9 as 13 is to 39.

In the foregoing proportion, 3 and 13 are the *antecedents*, and 9 and 39 are the *consequents*.

398. The first and the last term of a proportion constitute the *extremes*; the second and the third the *means*.

In the following proportion

$$5 : 15 :: 9 : 27$$

5 and 27 are the extremes, 15 and 9 are the means.

The foregoing proportion may be written

$$\frac{5}{15} = \frac{9}{27}.$$

Multiplying each of these two fractions by the product of the denominators, 15×27 , we have

$$\frac{5 \times 15 \times 27}{15} = \frac{9 \times 15 \times 27}{27}.$$

Cancelling, $5 \times 27 = 9 \times 15$.

In the same way it may be shown that in any proportion the product of the numbers in the extremes is equal to the product of the numbers in the means.

399. Written Exercises.

Find the missing term.

1. $3 : 4\frac{1}{2} :: 5 : x$.

As the product of the extremes is equal to the product of the means, 3 multiplied by x is equal to $4\frac{1}{2}$ multiplied by 5 ; i.e. $3x = 4\frac{1}{2} \times 5$. x , therefore, is equal to $\frac{4\frac{1}{2} \times 5}{3}$. This reduces to 8 . *Ans.*

To find an extreme, divide the product of the means by the other extreme.

2. $\frac{5}{6} : \frac{11}{24} :: x : \frac{11}{4}$.

The product of the means $\frac{11}{24} \times x$ equals the product of the extremes $\frac{5}{6} \times \frac{11}{4}$. x is equal, therefore, to $\frac{5}{6} \times \frac{11}{4} + \frac{11}{24}$. Inverting the divisor, we have $\frac{5}{6} \times \frac{11}{4} \times \frac{24}{11}$. Cancel.

To find a mean, divide the product of the extremes by the other mean.

3. $3\frac{1}{2} + 16 = ? \div x$.

6. $? : 19 :: 28 : 76$.

4. $5 : 7 :: 12\frac{1}{2} : x$.

7. $x : 15 :: 4 : \frac{4}{3}$.

5. $3 + x = 12 \div 20$.

8. $x : \frac{1}{2} :: 2 : 7$.

9. $\frac{2}{3} : x :: \frac{1}{2} : \frac{3}{5}$. 12. $x : \frac{5}{6} :: 11 : 3\frac{1}{2}$.
10. $\frac{1}{2} : \frac{2}{3} :: x : 2\frac{1}{2}$. 13. $x : 9 :: 4 : x$.
11. $1 : \frac{5}{6} :: 1\frac{2}{3} : x$.
14. 1 lb. 1 oz. : 2 lb. 4 oz. :: $17\frac{1}{2}$ ¢ : x ¢.
15. 3 qt. 1 pt. + 1 gal. = x ¢ + 80¢.
16. 4 bottles : x bottles = 6 pints : 15 pints.
17. x men : 9 men = 16 acres : 36 acres.

400. Oral Problems.

- If 9 eggs cost 25¢, what will 3 dozen cost?
- EXPLANATION.**—3 dozen, or 36, will cost 4 times as much as 9; 4 times 25¢ = \$1.
- If 7 pounds of flour cost 23¢, what will be paid for 49 pounds?
 - For \$5 I can get 12 straw hats. How many can I get for \$20?
 - A wheel makes 75 revolutions in 5 minutes. How many does it make in an hour?
 - \$100 principal gives \$6 interest. How much will be the interest of \$450 principal?
 - A merchant pays 75¢ freight on 125 pounds of merchandise. How much will be the freight on 1000 pounds at the same rate?
 - A locomotive goes 3 miles in 4 minutes. How far does it go in an hour?
 - 4 horses can eat a certain quantity of hay in 10 months. How long will it last 20 horses?
 - 12 men can do a piece of work in 15 days. How long will 36 men require?
 - 15 yards cost 270 cents. What will be the cost of 5 yards?

401. Written Problems.

1. If 9 cows cost \$267, what will be the cost of 36 at the same rate?

The ratio of the cost, \$267 : \$x, must be the same as the ratio of the number of cows, 9 : 36. Making the proportion, we have

$$9 : 36 :: 267 : x.$$

Therefore, $x = \frac{\$267 \times 36}{9}.$

Cancelling, $x = \$1068. \text{ Ans.}$

2. 7 barrels of sugar cost \$104.32. Find the cost of 42 barrels at the same rate.

3. A wheel makes 248 revolutions in 5 minutes. How many does it make in 1 hour 20 minutes?

Make the required number of revolutions the fourth term. The proportion will then be as follows:

$$5 \text{ minutes} : 80 \text{ minutes} :: 248 \text{ revolutions} : x \text{ revolutions.}$$

$$x = \frac{248 \text{ revolutions} \times 80}{5}.$$

4. A locomotive goes 2.8 miles in 4 minutes. How far does it go in an hour?

5. From 9 pounds of yarn are made 42 yards of dress goods. How many yards can be made from 165 pounds of yarn?

How many pounds of yarn are needed for 196 yards of goods?

6. If 17 men receive \$357 for a week's work, how much should 24 men receive?

7. If 17 men take 27 days to finish some work, how long would it take 51 men?

NOTE. — The *work* done by 51 men would be $\frac{51}{17}$ of the work done by 17 men. The *time* required by 51 men would be $\frac{17}{51}$ of the time required by 17 men.

8. When a sum of money is divided among 48 persons, each receives \$27.50. How much would each receive if the same sum were divided among 16 persons?

9. For \$85 I can purchase 238 yards of dress goods. How many yards can I purchase for \$5?

10. A can do a piece of work in 6 days; B can do it in 7 days. If B's wages are \$2.10 per day, how much should A receive per day?

11. If for 7s. 6d. I can buy 9 pounds of raisins, how many pounds can I buy for £56 16s.?

12. A quantity of provisions would last a ship's crew 20 days, allowing each man 2 lb. 4 oz. daily. What should each man be allowed so as to make the provisions last 4 days longer?

$$24 \text{ days} : 20 \text{ days} :: 36 \text{ ounces} : x \text{ ounces.}$$

13. If 40 men are able to do a piece of work in 10 hours, how many extra men must be employed to finish it in 8 hours?

$$8 \text{ hours} : 10 \text{ hours} :: 40 \text{ men} : x \text{ men.} \quad \text{The number of extra men is } x - 40.$$

14. If it requires 40 yards of carpet 2 ft. 9 in. wide to cover a floor, how many yards of carpet 2 ft. 6 in. wide would be needed?

15. How long will it take a train to go 112 miles, at the rate of 46 miles in 1 hr. 20 min. 30 sec.?

16. If a beam 5 ft. 6 in. long, 10 inches wide, and 8 inches thick weighs 924 pounds, find the length of another beam of the same material which weighs 3024 pounds, and whose end is a square foot.

PARTITIVE PROPORTION.**402. Preliminary Exercises.**

- Coin silver consists of 9 parts silver and 1 part copper. What is the ratio of the weight of the silver in a dime to the weight of the coin?
- What is the ratio of the weight of the copper to the weight of the coin?
- How many ounces of copper are there in a bar of coin silver weighing 90 ounces? How many ounces of pure silver?

403. Partitive proportion is the process of dividing a number into parts proportional to given numbers.

404. Written Problems.

- Divide 180 into parts proportional to 2, 3, and 4.

If the parts were 2, 3, and 4, the whole number would be $2 + 3 + 4$, or 9. The ratio of the whole to the first part must be 9 to 2; of the second, 9 to 3; of the third, 9 to 4. These ratios give rise to the proportions indicated.

$$9 : 2 :: 180 : x. \quad \therefore x = 40.$$

$$9 : 3 :: 180 : y. \quad \therefore y = 60.$$

$$9 : 4 :: 180 : z. \quad \therefore z = 80. \quad \text{Ans. } 40, 60, \text{ and } 80.$$

- Gunpowder is composed of 15 parts of saltpeter, 2 of sulphur, and 3 of charcoal, mixed together. How many pounds of each are there in 72 pounds of powder?

15 In a mixture of 15 lb. + 2 lb. + 3 lb., or 20 lb., there will be
 2 15 lb. saltpeter; hence, the ratio of the whole weight to the
 3 weight of the saltpeter is 20 lb. to 15 lb., etc.

$$\underline{20} : 15 :: 72 : \text{number of pounds of saltpeter.}$$

$$20 : 2 :: 72 : \text{number of pounds of sulphur.}$$

$$20 : 3 :: 72 : \text{number of pounds of charcoal.}$$

3. A bankrupt surrenders property worth \$1287 for the benefit of three creditors to whom he owes \$750, \$1125, and \$1245, respectively. How much should each creditor receive?

4. A had on storage in a warehouse 2400 bales of cotton, B 1500 bales, and C 1100 bales. After a fire that destroyed all distinguishing marks, the damaged cotton was sold for \$10,000. How should this sum be divided?

5. Our standard gold coin consists of 900 parts gold, 90 parts silver, 10 parts copper. What is the quantity of each metal in 50 pounds of coin?

6. Two men hire a pasture for \$45. One puts in 15 cows; the other puts in 12 cows. What should each pay?

7. A and B hire a boat for 50 days, paying \$30. A uses it 27 days; B uses it 23 days. How much should each pay?

8. Three farmers together paid \$54 for threshing their grain. A threshed his crop of 900 bu.; B threshed his crop of 828 bu.; C 672 bu. What did each pay?

9. A and B contract to haul a pile of lumber for \$105. A furnishes 3 teams, and B 4 teams. How much does B receive?

10. Three merchants shipped a cargo of iron by sea. A sent 180 tons, B sent 105 tons, C sent 315 tons. During a storm the sailors were obliged to throw overboard 180 tons to save the vessel. Assuming that the cargo should sustain one fourth of the loss, what portion of the loss should each merchant sustain?

11. Divide 90 into two parts which shall be to each other as 9 to 1.

PARTNERSHIP.**405. Written Problems.**

1. B and C gain by trade \$182. What is the gain of each, B having put in \$300, and C \$400?

The total investment is \$700. The ratio of the total investment to B's investment is 700 to 300. This should be the ratio of the total profit to B's share, etc.

$$\underline{300} \quad 700 : 300 :: \$182 : \text{B's share.}$$

$$\underline{400} \quad 700 : 400 :: \$182 : \text{C's share.}$$

Make proportions whose antecedents in each case are the total investment and the total profit, the consequents being the investment of one partner and his share of the profit.

2. A, B, and C invest \$720, \$340, and \$960, respectively. The profits are \$101. What is each one's share?

3. A, B, and C buy a house for \$7500. A furnishes \$2000; B, \$2500; C, the remainder. The yearly rent, less expenses, is \$576. To what amount is each entitled?

4. M and N entered into partnership. M puts \$200 into the business for 5 months, and N \$300 for 4 months. They gained \$132. Find the share of each.

An investment of \$200 for 5 months is equivalent to an investment of \$1000 for 1 month; an investment of \$300 for 4 months, to \$1200 for 1 month.

$$\underline{200 \times 5 = 1000} \quad 2200 : 1000 :: \$132 : \text{M's share.}$$

$$\underline{300 \times 4 = 1200} \quad 2200 : 1200 :: \$132 : \text{N's share.}$$

In ascertaining the ratio of the whole capital to the share contributed by each, \$1000 and \$1200 are taken as representing the shares of each in a total capital of \$2200.

Multiply each partner's share of the capital by the time it is in the business, and consider the products, respectively, as the sums contributed by the partners.

NOTE. — This mode of ascertaining a partner's share of profits or losses is based upon the assumption that the agreement of the partners does not provide for a different division.

5. X and Y rent a field for \$32. X puts in 8 horses for 6 months, and Y 10 horses for 8 months. How many dollars should each pay?

8 horses for 6 months = how many for one month?

10 horses for 8 months = how many for one month?

6. Three men hire a pasture for \$84. One puts in 15 cows for 12 weeks; the second puts in 20 cows for 6 weeks; the third puts in 18 cows for 10 weeks. What amount should each pay?

7. Four men hire a pasture field together. The first pastures 4 cows 18 weeks; the second, 5 cows $12\frac{1}{2}$ weeks; the third, 11 cows $6\frac{1}{2}$ weeks; the fourth, 9 cows 16 weeks. What part of the rent should each pay?

8. Two men hire a pasture for \$420. A puts in 300 sheep for 5 weeks, and B puts in 450 sheep for 6 weeks. What should each pay?

9. A, B, and C enter into partnership. A puts in \$500 for 4 months, B \$400 for 6 months, and C \$800 for 3 months; they gain \$340. Find each man's share of the gain.

10. A partnership is formed between A with a capital of \$1500 and B with a capital of \$2500. Six months thereafter they take in C with a capital of \$4000. How should a profit of \$3500 be divided at the end of the year?

11. A and B form a partnership. A furnishes \$2000, B \$3000. After a year A furnishes an additional \$1000. At the end of 2 years the business is disposed of for \$7100. How much should each receive?

SUGGESTION.—A receives his \$3000 and how much of the profits? Should he receive as much as B, who had \$3000 in the business the whole time?

COMPOUND PROPORTION.

406. A *compound proportion* is one in which either ratio is compound.

407. Written Problems.

1. If 72 men dig a ditch 20 yd. long, 1 ft. 6 in. broad, 4 ft. deep, in 3 days of 10 hours each, how many men would be required to dig a ditch 30 yd. long, 2 ft. 3 in. broad, and 5 ft. deep, in 15 days of 9 hours each?

Since the number of men is required, 72 men is made the third term of the proportion. Considering the length alone, the ratio of 72 men to the required number would be equal to the ratio of 20 feet to 30 feet. Considering the width, the ratio would be 18 inches to 27 inches. Considering the depth, the ratio would be 4 feet to 5 feet. Considering the number of days, the ratio would be 15 days to 3 days. Considering the number of hours per day, the ratio would be 9 hours to 10 hours. Dividing the product of the means by the product of the extremes, the number of men is found to be 45.

Place the number required as the fourth term, making the like number the third term. Arrange the couplets, considering the effect of each separately on the result. Divide the product of the means by the product of the extremes.

2. If 45 horses eat $1\frac{1}{2}$ tons of hay in 30 days, how many tons should last 84 horses 56 days?

3. If 4 men, working 8 hours per day, can mow a meadow in 3 days, how many men, working 9 hours per day, can mow a meadow three times as large in 4 days?

4. If 10 men, working 8 hours per day, can build a certain wall in 6 days, how many hours a day must 12 men work to build the same wall in 4 days?

5. If 108 men can build a fort in $12\frac{1}{2}$ days of $12\frac{1}{2}$ hours each, in how many days can 84 men build it by working $10\frac{1}{2}$ hours daily?

6. What will it cost to transport 1000 pounds of mail matter 1000 miles, at \$1 per 100 pounds per 100 miles?

7. If 12 men can do a piece of work in 20 days, what number of men will be required to do four times as much work in a fifth part of the time?

8. If 14 men can mow 168 acres in 12 days of 8 hr. 15 min. each, how many acres can 20 men mow in 11 days of 7 hr. 48 min. each?

9. If 5 needlewomen can do a piece of work in 11 days of 9 hours each, how long will it take 3 needlewomen to do two such pieces, supposing them to work $10\frac{1}{2}$ hours each day?

10. A employs a capital of \$2500 in business, and at the end of 3 years takes into partnership B, who furnishes \$4000. Four years later they are joined by C, with a capital of \$5000. At the end of 12 years from the commencement of the business the profits, amounting to \$15,000, are divided. What amount should each receive?

A's money is in the business how many years? B's how many years? C's how many?

11. A and B rented a field for a year for \$175. A put in 6 horses for the whole time; B put in 5 horses for 11 months and 3 horses for 5 months. How much of the rent had each to pay?

12. A field of grain was to be cut down by 40 men in 10 days. Eight of the men, however, failed to come. How long did it take the others to do the work?

REVIEW.**408. Oral Problems.**

1. How many weeks will $4\frac{1}{2}$ tons of coal last Mrs. Bright, if she uses $\frac{8}{15}$ of a ton each week?
2. I can buy 2 pairs of shoes for 12 shillings. How many pairs at the same rate can I buy for £3?
3. If two-thirds of your age is 8 years and 4 months, how old are you?
4. 5 quarts equal what decimal of a peck?
5. What is the cost of 700 pounds of coal at \$7 a ton?
6. How much would you pay for $2\frac{2}{3}$ yards of cloth at $37\frac{1}{2}\text{¢}$ a yard?
7. In what time will \$50, at 6%, give \$18 interest?
8. If I buy an article for \$75 and sell it for \$50, what is my loss per cent?
9. By selling an article for \$9, a man gained 25%. How many dollars would he have gained if he had sold the article at an advance of 50% over cost?
10. How many quarts of peanuts in 1 bushel and 3 pecks?
11. What would be the cost of 120 books at $66\frac{2}{3}\text{¢}$ each?
12. Change 66,321 mills to dollars.
13. \$120 is $\frac{1}{5}$ per cent of what number of dollars?
14. In what time will \$50 double itself at 8%?
15. If \$1 is paid for insuring a piano worth \$500, what is the rate of insurance?
16. Into how many lots, containing $\frac{2}{3}$ of an acre each, can 8 acres be divided?
17. A man lends \$1200 at 6%, and 1500 at 5%. What is the difference in the amount of yearly interest due on each?

18. A man owning $\frac{2}{3}$ of a ship sold $\frac{2}{3}$ of his share. What part of the ship did he still own?

19. How many rings, each 2 pwt. 12 gr., can be made from $\frac{1}{2}$ pound of gold?

20. Find the number of square inches on the surface of a block 10 inches long by 4 inches wide by 3 inches thick.

409. Written Problems.

1. A traveller walked $23\frac{1}{2}$ miles the first day, $3\frac{1}{4}$ miles more the second day than the first, and $3\frac{1}{2}$ miles more the third day than the second. How far did he walk in the three days?

2. Multiply 63.15 by 1.04; divide the product by 6.25, and subtract the quotient from 11

3. How many bricks, 8 inches long and 4 inches wide, will be needed to make a sidewalk 26 feet long and 4 feet wide?

4. If it costs \$10.24 to carry 1500 pounds 356 miles, what will it cost to carry 2700 pounds 890 miles?

5. A house rents for \$30 a month, and the owner pays \$75 a year for taxes and repairs. What is the value of the house, if his net profit is 5 per cent per annum?

6. A loaned B a sum of money at $4\frac{1}{2}$ per cent interest per annum. At the end of 18 months B paid the debt, principal and interest, in all \$1814.75. What was the sum borrowed?

7. If a 5-months note for \$760, dated March 13, is discounted at a bank May 23, the rate being 7 per cent a year, what will be the proceeds?

8. A grocer bought 40 gallons of maple syrup at the rate of 4 gallons for \$6, and sold it at the rate of 5 gallons for \$8. What was the whole gain, and the gain per cent?

9. Two pictures were sold for \$99 each. On one there was a gain of 10%; on the other a loss of 10%. Was there a gain or a loss on the sale of both, and how much?

10.

NEW YORK, Jan. 1, 1904.

One year after date I promise to pay J. Edward Swanson Eight Hundred Dollars for value received, with interest.

\$800₁₀₀.

RUFUS L. SCOTT.

Indorsed as follows: Apr. 1, 1904, \$10; July 1, 1904, \$35; Nov. 1, 1904, \$100.

What was due Jan. 1, 1905? (Merchant's Rule.)

11. What is the difference on a bill of \$780, between a discount of 40% and a discount of 35 and 5%?

12. How many cords in a pile of wood 42 feet long, 12 feet high, and 8 feet wide? Find its cost at \$6.35 per cord.

13. What principal, on interest for 2 yr. 6 mo. at 4%, will gain \$850?

14. What is the cost of insuring a house, worth \$25,000, for $\frac{1}{4}$ of its value at 1½%?

15. At 9¢ a cubic foot what will be the cost of a block of stone 9 ft. long, 4 ft. wide, and 5 ft. 6 in. thick?

16. If a steeple 150 feet high casts a shadow of 275 feet, how long a shadow will be cast by a man 6 feet tall, at the same time of day?

17. The tax to be raised in a certain town is \$1350. The taxable property is valued at \$108,000. What is the tax on one dollar?

18. Mr. Fox buys one-fifth of an acre of land for \$21.78. For how much a square foot must he sell it to gain 20%?

19. What is the cost of covering a floor $16\frac{1}{2}$ ft. long, 12 ft. wide, with oil-cloth $1\frac{1}{2}$ yd. wide, at 75¢ a yard?

20. The edges of a large cubical box are 5 feet long. How many square feet of paper will cover the outside of the box?

21. A field 110 yards long and 44 yards wide contains an acre. What is the area of a field 220 yards long and 88 yards wide? Of one 440 yards long and 176 yards wide?

$$110 \times 44 : 220 \times 88 :: 1 \text{ acre} : x \text{ acres.}$$

22. If a steel bar 12 feet long, 4 inches broad, and $2\frac{1}{2}$ inches thick weighs 480 pounds, what is the weight of another steel bar 18 feet long, 3 inches broad, and 2 inches thick?

23. At a certain hour a pole 6 feet high casts a shadow measuring 4 ft. 2 in. Calculate the height of a steeple whose shadow at the same hour is 104 ft. 2 in.

24. If 7 men receive \$126 for 5 weeks' work, how much should they receive for 9 weeks' work?

25. If 76 boards, each 14 feet long and 10 inches wide, are worth \$19.76, how much would 50 such boards be worth?

INVOLUTION.

410. *Involution* is finding any power of a number.

A *power* of a number is the product obtained by using the number a certain number of times as a factor.

2 is the first power of 2. 2×2 , or 4, is the second power of 2. $2 \times 2 \times 2$, or 8, is the third power of 2, etc.

411. The second power of a number is called its *square*; the third power is called its *cube*.

412. The power of a number is indicated by writing a small figure, called an *exponent* a little to the right of the upper part of a number.

The square of 2 is written 2^2 .

The cube of 2 is written 2^3 .

The fourth power of 2 is written 2^4 .

$$5^2 = 25, \quad 12^2 = 144.$$

What is the square of 4? Of 6? Of 7? Of 9? Of 10?
Of 11?

Square 13. 15. 21. 16. 19. $14^2 = ?$ $17^2 = ?$ $54^2 = ?$
 $33^2 = ?$

413. The square of 25 = $(20 + 5) \times (20 + 5)$.

	$20 + 5$
	$\overline{20 + 5}$
Multiplying by 20	$\overline{20^2 + }$ 20×5
Multiplying by 5	$\overline{20 \times 5 + 5^2}$
	$20^2 + 2(20 \times 5) + 5^2 = 400 + 200 + 25 = 625.$

414. The square of the sum of two numbers is equal to the square of the first + twice the product of the first by the second + the square of the second.

$$13^2 = (10 + 3)^2 = 10^2 + 2(10 \times 3) + 3^2 = ?$$

$$18^2 = (10 + 8)^2 = 100 + 160 + 64 = ?$$

$$27^2 = (20 + 7)^2 = 400 + 280 + 49 = ?$$

415. Oral Exercises.

Square:

$$\begin{array}{lllll} 1. \quad 19. & 4. \quad 26. & 7. \quad 51. & 10. \quad 32. & 13. \quad 27. \\ 2. \quad 22. & 5. \quad 31. & 8. \quad 61. & 11. \quad 42. & 14. \quad 33. \\ 3. \quad 24. & 6. \quad 41. & 9. \quad 23. & 12. \quad 52. & 15. \quad 43. \end{array}$$

EVOLUTION.

416. *Evolution* is finding any root of a number.

A *root* is one of the equal factors of a number.

The *square root* of a number is one of its two equal factors.

The square root of 4 is 2; of 9 is 3; of 16 is 4; of 25 is 5.

417. Give the square root of 36. Of 64. Of 81. Of 121. Of 49. Of 100. Of 144.

418. The sign of a square root is $\sqrt{}$.

$$\sqrt{81} = 9. \quad \sqrt{121} = ?. \quad \sqrt{25} = ?. \quad \sqrt{49} = ?.$$

SQUARE ROOT.

419. Find the square root of 169.

$10^2 = 100$. $20^2 = 400$. The square root is between 10 and 20; it is, therefore, 10 + a second number.

$$169 = 10^2 + 2(10 \times \text{second}) + \text{second}^2.$$

$$169 = 100 + 20 \times \text{second} + \text{second}^2.$$

$$20 \times \text{second} + \text{second}^2 = 69.$$

From this it appears that the second number is 3, since

$$20 \times 3 + 3^2 = 69.$$

420. It may be shown in this way:

$$\begin{array}{r}
 & \text{10 (first number)} \\
 & \overline{169} \\
 20) & \overline{10^2 = 100} \\
 & \overline{69(3 \text{ second number})} \\
 & \overline{60} \\
 & \overline{9} \\
 & \overline{3^2 = 9}
 \end{array}$$

Ans. $10 + 3 = 13$.

421. Find the square root of 2116.

$$\begin{array}{r}
 & 40 \text{ (first number)} \\
 \overline{2116} \\
 40^2 & 1600 \\
 40 \times 2 = 80, \text{ trial divisor }) 516 \text{ (6 second number)} \\
 & 480 \\
 & \overline{36} = 6^2
 \end{array}$$

Ans. 46.

Instead of multiplying the trial divisor by the second number, and then ascertaining whether the remainder is the square of the second number, the second number is added to the trial divisor and this sum is multiplied by the second number.

In practice, the work is shortened by omitting the ciphers.

$$\begin{array}{r}
 & 40 \text{ (first number)} & 4 \quad 6 \text{ Ans.} \\
 \overline{2116} & & \overline{21'16} \\
 & 1600 & 16 \\
 (2 \times 40) + 6 = 86 & \overline{516 \text{ (6 second number)}} & 86 \overline{516} \\
 & \underline{516} & \underline{516}
 \end{array}$$

First, point off in periods of two figures, commencing at units. Find the greatest square in the first period, and place the root in the quotient. Subtract the square from the first period and bring down the next period. Multiply the quotient figure by 2, and use it as a trial divisor. Place the second figure in the quotient and annex it also to the trial divisor. Multiply the figures in the trial divisor by the second quotient figure. Bring down the next period, and proceed as before until the square root is found.

422. Written Exercises.

Extract the square root:

- | | | | |
|---------|----------|----------|-----------|
| 1. 196. | 4. 1225. | 7. 2809. | 10. 6889. |
| 2. 324. | 5. 1764. | 8. 3721. | 11. 8281. |
| 3. 676. | 6. 1936. | 9. 5184. | 12. 9025. |

423. Find the square root:

NOTE. — Extract the square root of each term separately.

$$1. \frac{4}{25}.$$

$$4. \frac{86}{121}.$$

$$7. \frac{824}{2209}.$$

$$2. \frac{9}{64}.$$

$$5. \frac{49}{144}.$$

$$8. \frac{529}{844}.$$

$$3. \frac{169}{441}.$$

$$6. \frac{225}{1024}.$$

$$9. \frac{576}{625}.$$

NOTE. — Before extracting the square root of the following, reduce the mixed numbers to improper fractions.

$$10. 12\frac{1}{4}.$$

$$12. 2\frac{11}{16}.$$

$$14. 156\frac{1}{4}.$$

$$11. 11\frac{1}{8}.$$

$$13. 10\frac{811}{625}.$$

$$15. 264\frac{1}{16}.$$

424. Find the square root of 425,104.

$$\begin{array}{r}
 & 6 & 5 & 2 \\
 \sqrt{42'51'04} \\
 -42 \\
 \hline
 & 5 & 1 \\
 12 | 5 & & \hline
 & 6 & 51 \\
 130 | 2 & & \hline
 & 26 & 04 & \text{Ans. } 652.
 \end{array}$$

In finding any figure of the root after the first, we multiply the other figure or figures by 2 for a trial divisor.

425. Find the square root of 20,857,489.

$$\begin{array}{r}
 & 4 & 5 & 6 & 7 \\
 \sqrt{20'85'74'89} \\
 -20 \\
 \hline
 & 85 & & 4 & 85 \\
 90 | 6 & & & 60 & 74 \\
 912 | 7 & & & \hline
 & 638 & 89 & \text{Ans. } 4567.
 \end{array}$$

Find the square root of

$$1. 64,516.$$

$$4. 71,824.$$

$$2. 73,441.$$

$$5. 141,376.$$

$$3. 18,769.$$

$$6. .702244.$$

426. Written Exercises.

Find the square roots to two decimal places:

$$1. \ 7. \quad 2. \ 14. \quad 3. \ 38. \quad 4. \ 74. \quad 5. \ 350.$$

$$6. \text{ Find the square root of } 3.6. \quad \sqrt{3.6} = \sqrt{3.60}$$

NOTE. — Commence at the units and point off two places to the right as well as to the left, annexing a decimal cipher, if necessary.

$$\begin{array}{r} 1.89+ \\ 3.60'00 \\ \hline & 1 \\ & 2.60 \\ & 2.24 \\ 3.69 & \underline{3.600} \\ & 3.321 \end{array}$$

$$7. \ 6.4. \quad 8. \ .121. \quad 9. \ .144. \quad 10. \ .196. \quad 11. \ .225$$

APPLICATIONS OF SQUARE ROOT.**427. Written Problems.**

1. How many inches in the side of a square table top containing 529 square inches?

2. The surface of a square piece of board contains 3 sq. ft. 97 sq. in. What is the length of one side in feet and inches? (Reduce area to square inches.)

3. How many rods long is a square field containing 90 acres? How many yards of fence would be needed to enclose it?

4. Land surveyors use a measure called a *chain*. What is its length in rods, 10 square chains being equal to an acre? What is the length in feet?

It is subdivided into 100 "links." Find the length of a link in inches and decimal.

5. The surface of the six equal faces of a cube is 1350 square inches. What is the length of each edge of the cube?

428. Preliminary Exercises.

1. Carefully construct a right-angled triangle, base, 4 inches, perpendicular, 3 inches. Measure the hypotenuse.

Take the square of the length of each side and endeavor to show the relation between the square of the hypotenuse and the squares of the other two sides.

2. Construct a right-angled triangle, base, 3 inches, perpendicular, $1\frac{1}{4}$ inches. Measure the hypotenuse, and see if the relation between this hypotenuse and the other two sides of this triangle is the same as that found in the other triangle.

3. A right-angled triangle has a base 12 inches long; its perpendicular is $3\frac{1}{2}$ inches. What is the length of the hypotenuse?

4. The hypotenuse of a right-angled triangle is 25 inches; its perpendicular is 7 inches. What is the base?

5. The base of a right-angled triangle is 12 feet; the hypotenuse is 13 feet. Find the perpendicular.

429. Draw a right-angled triangle (Fig. 1). Upon each side construct a square (Fig. 2). From the upper portion of the largest square *C*, cut a right-angled triangle of the same



FIG. 1

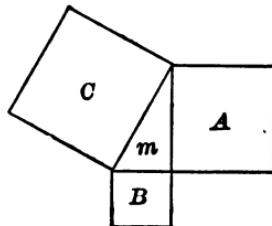


FIG. 2

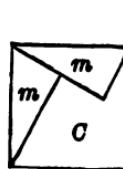


FIG. 3



FIG. 4

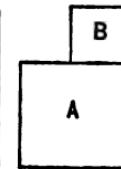


FIG. 5

dimensions as those of the original triangle *m*. Cut another triangle of the same dimensions from the left-hand portion (Fig. 3). Place one of these triangles below the remainder

of the square *C*, and the other at the right, as in Fig. 4, and the resulting polygon will be exactly equal in surface to the two squares *A* and *B* (Fig. 5).

430. The square described on the hypotenuse of a right-angled triangle is equal to the sum of the squares described on the other two sides.

431. Written Exercises.

Find the missing side of each of the following ten right-angled triangles:

1. Base, 15; perpendicular, 8; hypotenuse, ?.

$$\begin{aligned}\text{Square of hypotenuse} &= 15^2 + 8^2 \\ &= 225 + 64 \\ &= 289.\end{aligned}$$

$$\text{Hypotenuse} = \sqrt{289}, \text{ or } 17.$$

To find the hypotenuse, extract the square root of the sum of the squares of the other sides.

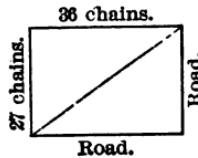
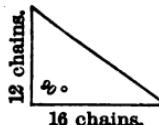
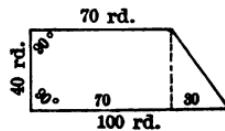
2. Base, 35; perpendicular, ?; hypotenuse, 37.

$$\begin{aligned}B^2 + P^2 &= H^2; \\ 35^2 + P^2 &= 37^2; \\ 1225 + P^2 &= 1369; \\ P^2 &= 144; \\ P &= 12.\end{aligned}$$

To find the base or the perpendicular, extract the square root of the square of the hypotenuse diminished by the square of the given side.

3. Base, ?; perpendicular, 15; hypotenuse, 39.
4. Base, 20; perpendicular, 21; hypotenuse, ?.

5. Base, ?; perpendicular, 45; hypotenuse, 53.
 6. Base, 56; perpendicular, ?; hypotenuse, 65.
 7. Base, 55; perpendicular, 48; hypotenuse, ?.
 8. Base, ?; perpendicular, 14; hypotenuse, 50.
 9. Base, 63; perpendicular, ?; hypotenuse, 65.
 10. Base, 112; perpendicular, 15; hypotenuse, ?.
 11. Find the area in acres of a right-angled triangle, the length of the sides being 24 rods, 7 rods, 25 rods.
 12. A courtyard 84 feet by 36 feet is to be paved with flag-stones measuring 6 feet by 3 feet. How many stones will be needed? What will be the cost of the work at \$1.25 per square yard?
 13. Find the length of the fourth side of the following piece of ground. How many yards in the perimeter? How many acres does it contain?
14. Find the perimeter in rods of the field shown in the diagram.
- 1 chain = 66 feet.
- NOTE.** — A right angle contains 90 degrees.
15. What is the length of the diagonal of a rectangular field 90 yards wide, 120 yards long?
 16. The dotted line in the accompanying diagram indicates a path through the field. How many yards are saved by taking the path instead of following the road?
 17. Find the length (in rods and a decimal) of the diagonal of a square 40-acre field.



CUBE ROOT.

432. To cube a number is to employ it three times as a factor.

The cube of 4, written 4^3 , is $4 \times 4 \times 4$, or 64.

Find the cube of 1, 9, 6, 3, 5, 8, 2, 7.

To find the cube root of a number is to find one of the three equal factors of the number.

The cube root of 343, written $\sqrt[3]{343}$, is 7.

The cube of $25, 20 + 5$, is equal to the following:

We have seen (Art. 418) that

$$(20 + 5)^3 = 20^3 + 2 \times 20 \times 5 + 5^3$$

Multiplying by $\frac{20 + 5}{20 + 5}$ we have

$$\text{Product by } 20 = \frac{20^3 + 2 \times 20^2 \times 5 + 20 \times 5^2}{20 + 5}$$

$$\text{Product by } 5 = \frac{20^2 \times 5 + 2 \times 20 \times 5^2 + 5^3}{20 + 5}$$

$$(20 + 5)^3 = \frac{20^3 + 3 \times 20^2 \times 5 + 3 \times 20 \times 5^2 + 5^3}{20 + 5}$$

which may be written in this way,

$$20^3 + [(3 \times 20^2) + (3 \times 20 \times 5) + 5^3] \times 5.$$

433. Extract the cube root of 15,625.

We see by inspection that the cube root is between 20 and 30; that is, 20 + a second number. Subtract from 15,625 the cube of 20, 8,000. The remainder, 7,625, is equal to the second number multiplied by the sum of three times the square of the first (1,200), etc. Using 1,200 as a trial divisor, the second number is seen to be 6 or less.

$$\begin{array}{r} 20 + 5 \\ \hline 15,625 \end{array}$$

$$\begin{array}{r} (20)^3 = 8,000 \\ 3 \times 20^2 = 1,200 \quad 7,625 \text{ remainder} \end{array}$$

$$3 \times 20 \times 5 = 300$$

$$5^3 = 25$$

$$\begin{array}{r} 1,525 \\ \hline 7,625 \end{array}$$

Taking 5 as the second number, we add to the 1,200 three times the product of the first and second (300), and the square of the second (25), making a total of 1,525. Multiplying this sum by the second number, we get 7,625, which is equal to the difference between 15,625 and 8,000. The second number is, therefore, 5, and the cube root of 15,625 is 25.

$$\sqrt[3]{110,592}$$

$$\begin{array}{r}
 \frac{40+8}{110,592} \\
 8 \times 40^2 = 4,800 \quad 8^3 = 512 \\
 8 \times 40 \times 8 = 960 \quad 8 \times 80^2 = 19,200 \\
 \hline
 8^2 = 64 \quad 8 \times 80 \times 7 = 1,680 \\
 \hline
 5,824 \quad 46,592 \quad 7^2 = 49 \\
 \end{array}$$

Ans. 48.

$$\sqrt[3]{658,503}$$

$$\begin{array}{r}
 \frac{8 \quad 7}{658'503} \\
 8 \times 80^2 = 19,200 \quad 146,503 \\
 8 \times 80 \times 7 = 1,680 \\
 \hline
 20,929 \quad 146,503 \\
 \end{array}$$

Ans. 87.

In the last example we point off three places, beginning at the right, and find the greatest cube in the first period, placing its cube root as the first figure of the answer.

434. Find the cube root of the following:

- | | | |
|------------|-------------------------|--------------------------|
| 1. 2,197 | 6. 238,328 | 11. $\frac{8000}{12167}$ |
| 2. 9,261 | 7. 421,875 | 12. 3.375 |
| 3. 32,768 | 8. 551,368 | 13. $1\frac{11}{12}$ |
| 4. 68,921 | 9. $\frac{512}{729}$ | 14. $1\frac{897}{1331}$ |
| 5. 148,877 | 10. $\frac{1811}{2744}$ | 15. $5\frac{541}{729}$ |

435. Find the cube root of 9,938,375.

When the root contains more than two figures, continue, as shown in the accompanying example, taking for divisor three times the square of the first two figures considered as tens, plus three times the product of the first two figures considered as tens by the third figure, plus the square of the third figure.

$$\begin{array}{r}
 \frac{2 \quad 1 \quad 5}{9'938'375} \\
 8 \\
 3 \times 20^2 = 1200 \quad 1 \ 200 \quad \overline{1 \ 938} \\
 3 \times 20 \times 1 = 60 \\
 1^2 = 1 \quad 1 \ 261 \\
 \hline
 3 \times 210^2 = 132 \ 300 \quad \overline{677 \ 375} \\
 3 \times 210 \times 5 = 3 \ 150 \\
 5^2 = 25 \\
 \hline
 135 \ 475 \quad \overline{677 \ 375}
 \end{array}$$

436. Find the value of the following:

- | | | |
|--------------------------|---------------------------|--------------------------|
| 1. $\sqrt[3]{1,442,897}$ | 3. $\sqrt[3]{3,723,875}$ | 5. $\sqrt[3]{12.977875}$ |
| 2. $\sqrt[3]{1,906,624}$ | 4. $\sqrt[3]{39,651,821}$ | 6. $\sqrt[3]{66.923416}$ |

MENSURATION.

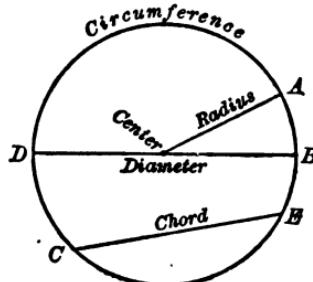
THE CIRCLE.

437. A *circle* is a plane figure whose boundary is at all points equally distant from the centre.

The curved line that forms the boundary is called the *circumference*.

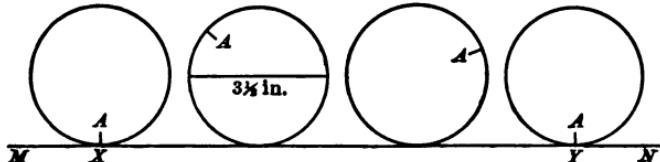
The *diameter* is any straight line drawn from one point of the circumference to another and passing through the centre.

The *radius* is any straight line drawn from the centre to the circumference.



438. Preliminary Exercises.

- Cut out of stiff paper a circle whose diameter measures $3\frac{1}{4}$ inches. Mark a point *A* on the circumference, and roll



the circle on a plane surface along the line *MN*. Make a mark at *X* where the point *A* touches the line at the beginning of its revolution, and at *Y* where *A* touches the line at the end. Measure the distance *XY*, which is the length of the circumference of the circle.

- If the distance between *X* and *Y* is 11 inches, what is the ratio of the diameter of a circle to the circumference?
- Draw several diameters in the circle you have cut out. Measure each. How do the diameters compare?
- What is the ratio between the diameter of a circle and the radius?

439. Written Exercises.

Find the circumference of a circle whose diameter is $3\frac{1}{2}$ inches.

$$3\frac{1}{2} \text{ inches} \times 3.1416 = 10.9956 \text{ inches. } \textit{Ans.}$$

The ratio between the circumference of a circle and its diameter has been ascertained to be 3.1416.

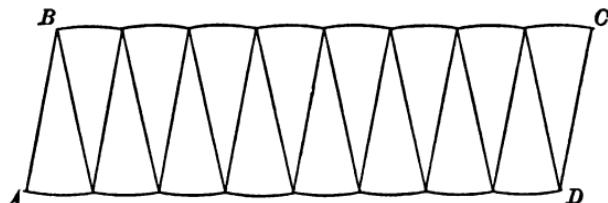
PROCESS. — *To find the circumference of a circle multiply the diameter by 3.1416.*

1. Find the circumference of a circle whose diameter is 25 feet.
2. The circumference of a circle measures 39.27 feet. What is the diameter?
3. The radius of a circle is 8 yards. Find its circumference.
4. The diameter of a bicycle wheel is 28 inches. How far does a bicycle go during 10 revolutions of the wheel?

AREAS OF CIRCLES.

440. Preliminary Exercises.

1. Divide a circle whose diameter measures $3\frac{1}{2}$ inches into sixteen equal parts by cuts passing through the centre in each case. Arrange the parts as shown in the accompanying figure :



2. When the diameter measures $3\frac{1}{2}$ inches, what is the length of AB ? What part of the diameter is AB ?

3. What part of the circumference is embraced between A and D ?

4. When the given circle is divided into a very great number of parts, what will be the length of AD ? Of AB ?

5. When the number of parts is extremely great, $ABCD$ becomes a rectangle. Find its area.

The number of square inches (feet, etc.) in the area of a circle is obtained by multiplying one-half the number of inches (feet, etc.) in the diameter by one-half the number in the circumference.

This may be expressed by the formula :

$$\text{Area of circle} = \frac{1}{2} \text{diameter} \times \frac{1}{2} \text{circumference}.$$

As the circumference equals diameter $\times 3.1416$, $\frac{1}{2}$ circumference equals radius $\times 3.1416$. Multiplying by $\frac{1}{2}$ diameter, or radius, we have :

$$\text{Area of circle} = \text{square of radius} \times 3.1416.$$

To find the area of a circle multiply the square of the radius by 3.1416.

441. Written Exercises.

1. What is the area of a circle whose radius is 36 feet?

$$1 \text{ sq. ft.} \times 36^2 \times 3.1416 = 1296 \text{ sq. ft.} \times 3.1416.$$

2. Find the area of a circle whose diameter is 50 yards.

3. What is the area of a circle whose circumference is 10 feet?

$$\text{Diameter} = \frac{10}{3.1416}; \quad \text{Radius} = \frac{5}{3.1416}.$$

$$R^2 = \frac{5 \times 5}{3.1416 \times 3.1416}; \quad R^2 \times 3.1416 = \frac{5 \times 5 \times 3.1416}{3.1416 \times 3.1416}. \quad \text{Cancel.}$$

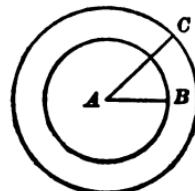
4. Calculate the area of a circle whose radius is 1 inch. Of a circle whose radius is 2 inches. What is the ratio of the two areas?

5. What is the ratio between the area of a circle whose radius is 1 inch and that of a circle whose radius is 3 inches?

Indicate operations and cancel.

6. How many square yards are there in a circular walk, the radius, AB , of the inner edge of walk being 10 feet, and that of the outer edge, AC , being 15 feet?

Find the difference between the area of a circle of 15 feet radius, and that of a circle of 10 feet radius.

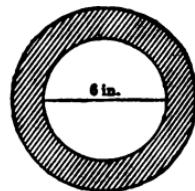


7. A circular flower bed 20 feet in diameter is surrounded by a walk 5 feet wide. How many square feet of surface does the walk contain?

If you have to subtract 100 times 3.1416 from 225 times 3.1416, how can you shorten the work?

8. How many square inches are there in the surface of a frame 3 inches wide, around a looking-glass 6 inches in diameter?

$$\text{Area} = ? \times 3.1416.$$



9. What is the ratio between the surface of the above frame and that of the looking-glass?

Indicate operations and cancel.

10. What is the radius of a circle whose area is 153.9384 square yards?

11. Find the radius of a circle whose area is 314.16 square inches.

12. Find the area of a circle whose circumference is 15.708 feet.

AREAS OF TRIANGLES.

442. Written Problems.

1. What is the area of a triangle whose sides measure 15, 16, and 17 inches, respectively?

15 From the half sum of the three sides subtract
16 each side separately. The square root of the con-
17 tinued product of the half sum and the three
2)48 remainders will be the area.

$$\begin{array}{l} 24 - 15 = 9 \\ 24 - 16 = 8 \\ 24 - 17 = 7 \end{array} \quad \sqrt{24 \times 9 \times 8 \times 7} = \sqrt{12,096} = 109.98$$

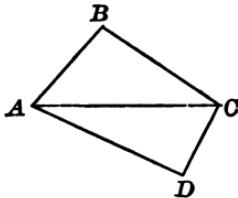
Ans. 109.98 square inches.

2. Find the area in square feet of a triangle whose sides measure 35 feet, 84 feet, 91 feet.

3. Find the area of a triangle whose sides measure 21, 28, and 35 rods, respectively.

4. In the following field, AB measures 39 rods; BC , 52 rods; CD , 25 rods; AD , 60 rods; and the diagonal, AC , 65 rods. Find the area of the field in square rods.

Find the area of each triangle separately.



5. Find the area of an isosceles triangle whose base is 30 yards, its equal sides measuring 25 yards.

6. What is the altitude of an isosceles triangle, base, 64 feet, equal sides, 68 feet? Find its area.

7. Find the area of an equilateral triangle, each side being 6 feet.

8. Find the area of a right-angled triangle, base, 42 feet, hypotenuse, 70 feet.

First ascertain the length of the perpendicular.

9. Find the area of an isosceles triangle, altitude, 48 feet, equal sides, 50 feet.

AREAS OF QUADRILATERALS.

443. Written Problems.

1. Find the area of a square whose diagonal is 150 rods.

SUGGESTION.—Calling one side of the square S , we have $S^2 + S^2 = 150^2$, 150 being the hypotenuse of an isosceles right-angled triangle, the other sides being the sides of the square. S^2 is the required area. Do not find the length of S .

2. Find the area of the rhomboid (Fig. 1).

NOTE.—The altitude is the perpendicular of a right-angled triangle having a base of 7 rods and a hypotenuse of 25 rods.

3. Of the rectangle (Fig. 2).

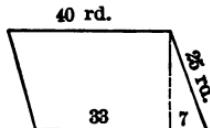


FIG. 1.

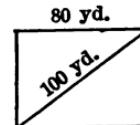


FIG. 2.

4. Of the rhombus (Fig. 3).

5. Of the trapezoid (Fig. 4).

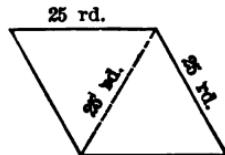


FIG. 3.

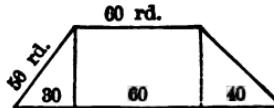


FIG. 4.

6. Of the trapezium (Fig. 5).

7. Of the rhombus (Fig. 6).

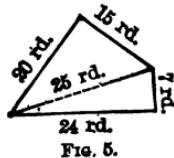


FIG. 5.

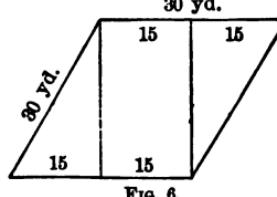


FIG. 6.

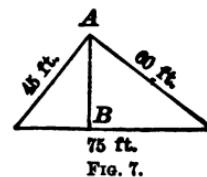


FIG. 7.

8. Find the altitude AB of the preceding triangle (Fig. 7).
 (First find the area.)

9. Find the diagonal (in rods) of the square whose area is 5 acres.

10. Find the area of a regular hexagon, composed of six equilateral triangles, each side being 6 inches (Fig. 8).

NOTE. — A plane figure bounded by straight lines is called a polygon. A three-sided polygon is called a triangle. A four-sided polygon is called a quadrilateral. A hexagon is a six-sided polygon. A regular polygon is one having all its sides and all its angles equal. The square is the only regular polygon of four sides.



FIG. 8.

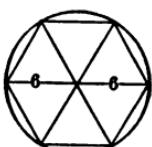


FIG. 9.

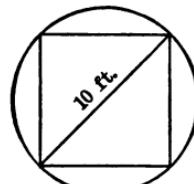


FIG. 10.

11. What is the area of the circle circumscribed about the above hexagon (Fig. 9)?

12. What is the area of the square inscribed in a circle whose diameter is 10 feet (Fig. 10)?

13. Find the area of a square circumscribing a circle whose diameter is 10 feet, and give the ratio of its area to that of the inscribed square.

14. Find the perimeter of a rectangle 80 yards long, the diagonal of which measures 100 yards.

15. A square piece of ground containing 40 acres is divided into 4 square fields of 10 acres each. How many rods of fence will be needed to enclose all the fields?

16. The area of a triangular plot is 480 square yards. Two of the sides are equal in length, and the third measures 32 yards. Find the perimeter.

SURFACES OF PRISMS AND OF CYLINDERS.

NOTE. — The pupils should first examine a number of prisms, right and oblique, regular and irregular, triangular, quadrangular, pentagonal, etc. Right and oblique cylinders should also be at hand.

444. A *prism* is a body bounded by plane faces, two of which are equal and parallel polygons, the remaining faces being parallelograms.

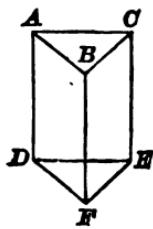


FIG. 1.

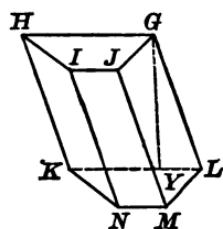


FIG. 2.

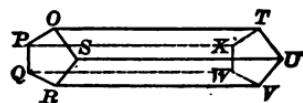


FIG. 3.

The two parallel faces of a prism are called its *bases*. The remaining faces taken together constitute its *convex surface*.

In Fig. 1, *ABC* and *DEF* are the bases; in Fig. 2 the bases are *GHIJ* and *KLMN*; in Fig. 3, *OPQRS* and *TUVWX*.

The sides *AB*, *CE*, etc., *GH*, *IN*, etc., *QR*, *OT*, etc., are called *edges*.

445. Prisms may be either *right* or *oblique*. The convex surface of a right prism consists of rectangles.

Fig. 1 is a right prism; Fig. 2 is an oblique prism.

NOTE. — When a prism is spoken of, a right prism is meant unless the word *oblique* is used.

The *altitude* of a prism is the perpendicular distance between the bases.

AD, *BF*, or *CE* is the altitude in Fig. 1. *GY* is the altitude in Fig. 2.

446. The number of sides in each base determines the name as *triangular* (Fig. 1), *quadrangular* (Fig. 2), *pentagonal* (Fig. 3), etc.

A quadrangular prism whose bases are parallelograms is called a *parallelopipedon*. Fig. 4 is an oblique parallelopipedon. Fig. 5 is a right parallelopipedon. Any two opposite faces of a parallelopipedon may be considered the bases.

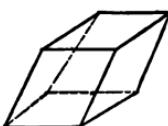


FIG. 4.

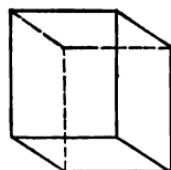
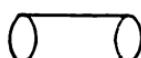


FIG. 5.

447. When the bases are regular polygons, the prism is said to be *regular*.

Fig. 1 is a right regular triangular prism; Fig. 2 is an oblique irregular quadrangular prism.

448. A cylinder is a body having two circular parallel plane faces, and one curved face.



The plane faces are the bases. The curved face constitutes the convex surface.

Cylinders, like prisms, are either *right* or *oblique*. The altitude of a cylinder is the perpendicular distance between the bases.



FIG. 7.



FIG. 8.

449. Written Problems.

NOTE. — The pupils should be encouraged to make cardboard models of the forms studied.

1. Find the convex surface of a square prism, one side of its base being 4 inches and its height 6 inches. Draw the development.



NOTE. — The convex surface is the surface exclusive of the bases.

2. Find the convex surface of a triangular prism, each side of whose base measures 4 inches and whose altitude is 6 inches. Draw the development.



3. Find the convex surface of an hexagonal prism, each side of its base being 4 inches and its altitude 6 inches. Draw the development.

4. Can you show that the convex surface of a prism is found by multiplying the perimeter of the base by the altitude (height) ?

5. Find the convex surface of a cylinder, the diameter of its base being 4 inches and its height 6 inches.

To find the convex surface of a right prism (or cylinder) multiply the perimeter (circumference) of the base by the height.

6. How do you find the entire surface of a prism or cylinder?

NOTE.—The entire surface is the surface including the bases.

7. What is the entire surface of a cube whose side is 7 inches? Of a cube whose side is 12 inches?

8. The entire surface of a cube is 216 square inches. What is the length of one side?

SUGGESTION.—Calling the length of one side L , the area of each face will be L^2 , and of the six faces, $6 L^2$. Then, $6 L^2 = 216$.

9. The convex surface of a cube is 144 square inches. Find the entire surface.

How many faces in the convex surface?

10. Find the entire surface of a square prism, one side of whose base measures 4 inches, and whose altitude is 6 inches.

Entire surface = convex surfaces + areas of bases.

11. The convex surface of a square prism is 600 square feet, the altitude is 15 feet. What is the length of one side of the base?

12. The entire surface of a square prism is 1650 square inches. One side of the base measures 15 inches. What is its convex surface? What is its altitude?

Convex surface = entire surface — area of bases.



SURFACES OF PYRAMIDS AND CONES.

450. A *pyramid* is a body whose convex surface is made up of triangles having a common vertex, the base of the pyramid being a polygon.

Pyramids are either *right* or *oblique*; *regular* or *irregular*; *triangular*, *quadrangular*, *pentagonal*, etc.

In a right pyramid, each of the triangles that make up the convex surface is isosceles. When, in addition, the pyramid is a regular one, these triangles will be equal to each other.

The altitude of any of these equal triangles constitutes the *slant height* of a right regular pyramid. The *altitude* of the prism is measured by a line drawn from the apex to the centre of the base.



FIG. 1.

FIG. 2.

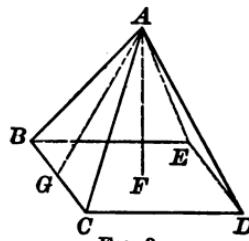


FIG. 3.

AG is the slant height of the square pyramid, Fig. 3. AF is its altitude.

451. The *cone* is a body having a single circular base, and a curved convex surface sloping to the apex.

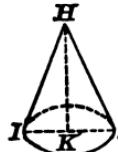


FIG. 4.

Fig. 5.

In the right cone, Fig. 4, HI is the slant height, and HK is the altitude. LO is the altitude of the oblique cone,

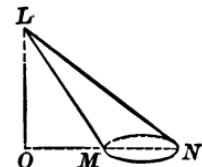
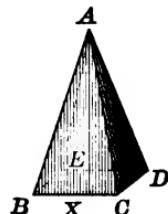


FIG. 5.

452. Written Problems.

1. The convex surface of a square pyramid consists of how many equal triangles? Find the convex surface when one side of its base measures 4 inches and its slant height (AX) 6 inches.

2. Draw the development.



To find the convex surface of a pyramid (or cone) multiply the perimeter (circumference) of the base by one-half the slant height.

3. Find the entire surface of the above pyramid.

Entire surface = convex surface + area of base.

4. Calculate the entire surface of a square pyramid whose slant height is 18 inches, the area of its base being 144 square inches.

5. Draw the developed convex surface of a cone, the diameter of whose base is 4 inches, and whose slant height is 6 inches.

Calculate the convex surface.

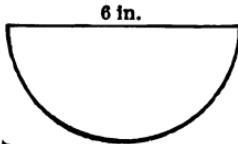


6. How many square inches of paper would be required to cover the side and the base of a cone 6 inches in diameter at the base, and having a slant height of 10 inches?

7. Calculate the slant height of a cone whose altitude is 12 inches, the diameter of its base being 10 inches. What is its convex surface?

NOTE.—The slant height is the hypotenuse of a right-angled triangle, the other sides measuring 12 in. and 5 in., respectively.

8. What is the convex surface of a cone, the diameter of whose base is 6 inches, and its slant height 10 inches? Draw the development.



9. A semicircular piece of paper 6 inches in diameter is folded into a hollow cone (without overlapping).



What will be the diameter AB of the mouth of the cone (the base)? What will be the slant height BC ?

**VOLUMES OF PRISMS AND OF PYRAMIDS; OF CYLINDERS
AND OF CONES.**

453. Written Problems.

SUGGESTION.—Have the pupils construct of cardboard a hollow square prism of convenient size, and a pyramid having base and altitude respectively equal to those of the prism. Let them use sand or water to ascertain how many times the contents of the pyramid must be taken to exactly fill the prism.

$$\text{Volume of prism or cylinder} = \text{area of base} \times \text{altitude}.$$

$$\text{Volume of pyramid or cone} = \text{area of base} \times \frac{1}{3} \text{altitude}.$$

1. Find the volume of a square pyramid, the area of the base being 9 square feet and the altitude 6 feet.

$$1 \text{ cu. ft.} \times 9 \times \frac{1}{3} \text{ of } 6.$$

2. What is the volume of a square pyramid whose altitude is 12 inches, one side of the base being 10 inches?

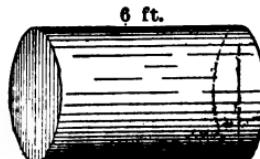
3. The base of a prism is a triangle whose sides measure 3, 4, and 5 inches respectively. Find the solidity, its altitude being 10 inches.

4. The base of a prism 19 feet high is a rectangle whose sides are 9 feet and 13 feet. How many cubic yards does it contain?

5. Find the volume of a prism whose bases are equilateral triangles, each side being 4 feet, and the height of the prism being 12 feet.

6. How many cubic feet are there in a stone roller 6 feet long, 8 feet in circumference?

7. Find the volume of a cone whose altitude is 18 meters, diameter of base 6 meters.

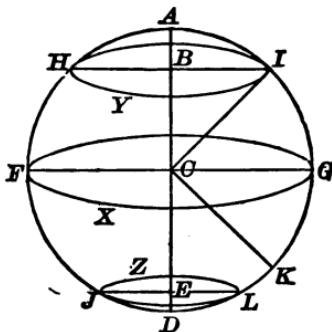


SURFACE OF SPHERE.

454. A *sphere* is a body all points on whose surface are equally distant from the centre.

The distance from the centre to the surface is called the *radius* of the sphere. The diameter is a line running between two points on the surface and passing through the centre.

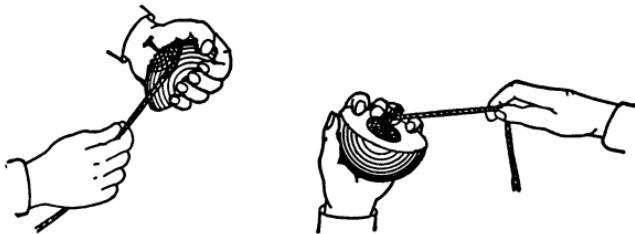
CG , CK , CD , CF , and CI are radii; AD and FG are diameters.



455. If a sphere be cut through at any part, the cut surface will be a circle. When the cutting plane passes through the centre of the sphere, the circle is called a *great circle*; other circles are called *small circles*.

$FXGC$ is a great circle; $HYIB$ and $JLEZ$ are small circles.

456. Take a wooden hemisphere and drive a tack into the centre of its curved surface. Commencing at the tack, carefully wind a waxed cord about the curved surface, in the way a boy winds a top. When this surface is exactly covered, cut the cord.



Wind the same cord around a tack driven into the plane surface of the base of the hemisphere, pressing it closely to the surface. When the latter is entirely covered, just one-half of the cord will be used.

As a hemisphere is made by passing the cutting plane through the centre of the sphere, its base is a great circle of the sphere.

The above experiment shows that the surface of the hemisphere is equal to that of two great circles of the same sphere.

457. The surface of a sphere is equal to that of four great circles.

Since the surface of a great circle of the sphere is $R^2 \times 3.1416$, the surface of the sphere is $4 R^2 \times 3.1416 = D^2 \times 3.1416$.

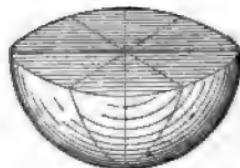
To find the surface of a sphere, multiply the square of the diameter by 3.1416.

458. Written Problems.

1. Find the surface of a sphere whose radius is 1 inch.
2. The diameter of a sphere is 2 inches. Find its surface.
3. What is the surface of a sphere whose circumference is 6.2832 inches?
4. At 10 cents a square foot, what will be the cost of gilding a sphere 12 inches in diameter?
5. Find the ratio between the surface of a sphere 1 foot in diameter, and the convex surface of a cylinder 1 foot high, the diameter of the base 1 foot.
6. What is the ratio between the surface of a sphere 1 foot in diameter, and the entire surface of a cylinder 1 foot high, the diameter of the base 1 foot?
7. Find the surface of a sphere whose circumference is 20 inches.
8. What is the ratio between the surfaces of two spheres whose diameters are 1 inch and 2 inches, respectively?
9. Find the ratio between the surfaces of two spheres whose diameters are 2 feet and 13 feet, respectively.

VOLUME OF SPHERE.

459. Cut up a sphere (a round potato, for instance) into a number of small pieces, passing the knife in each case through the centre of the



sphere. Each piece is a solid, having for its base a portion of the surface of the sphere, and for its altitude the radius of the sphere.

When the pieces become very numerous, the base of each may be considered a plane and the solid a pyramid. The volume of each



pyramid is equal to the base $\times \frac{1}{3}$ altitude ; and the total volume of all, which is the volume of the sphere, is equal to the total surface of all the bases, which is the surface of the sphere, multiplied by $\frac{1}{3}$ altitude, that is, $\frac{1}{3}$ radius, or $\frac{1}{6}$ diameter.

$$\begin{aligned} \text{Surface of sphere} &= D^2 \times 3.1416, \\ \text{therefore,} \quad \text{volume of sphere} &= D^2 \times 3.1416 \times \frac{1}{6} D = \\ &\quad \frac{1}{6} D^3 \times 3.1416. \end{aligned}$$

To find the volume of a sphere, multiply one-sixth of the cube of the diameter by 3.1416.

460. Written Problems.

1. Find the volume of a sphere whose radius is 3 inches.
1 cu. in. $\times 36 \times 3.1416.$
2. If the diameter of a sphere is 3 inches, what is its volume ?

3. What is the ratio between the volumes of two spheres whose diameters are one foot and two feet, respectively?
4. Find the ratio between the volume of a sphere 1 foot in diameter, and that of a cube whose side is 1 foot.
5. The radius of a sphere is 18 inches. What is the circumference of a great circle? The surface? The volume?
6. What is the weight of an iron cannon-ball 12 inches in diameter, considering the weight of a cubic foot of water as 1000 ounces, and considering iron 7.5 times as heavy as water?
7. Find the ratio between the volume of a sphere 4 inches in diameter, and that of a cylinder 4 inches in altitude, diameter of base 4 inches.

NOTE. — *Indicate the volume of each, and cancel.*

8. A man has a cubical block of hard wood, its side measuring one foot, which he wishes made into a sphere one foot in diameter. What decimal part of the block is cut away?

The volume of the sphere is *about* what fraction of the volume of the cube?

MISCELLANEOUS.

461. Written Problems.

1. If a piece of cloth is 20 yards long and $\frac{3}{4}$ yards broad, how broad is another piece of cloth 12 yards long that contains as many square yards as the former?
2. An iron beam 16 feet long, $2\frac{1}{4}$ feet broad, and 8 inches thick, weighs 1280 pounds. What is the length of a similar beam whose breadth is $3\frac{1}{2}$ feet, thickness $7\frac{1}{2}$ inches, and weight 2028 pounds?
3. What will it cost to carpet a room $22\frac{1}{2}$ feet long by $15\frac{1}{4}$ feet wide with carpet $2\frac{1}{4}$ feet wide, costing \$1.50 per yard?

4. What is the length of a box $6\frac{3}{4}$ feet wide and $7\frac{1}{2}$ feet high, that will exactly contain 12 boxes $4\frac{1}{2}$ feet long, $3\frac{1}{2}$ feet wide, and $2\frac{1}{2}$ feet deep?

5. What is the value, at \$120 per acre, of a square field whose side is 35.25 chains?

$$10 \text{ square chains} = 1 \text{ acre.}$$

6. Find the capacity, in bushels, of a bin 22 feet long, 14 feet wide, 12 feet high?

7. How many gallons will a tank hold, its dimensions being 4 ft. 1 in. by 3 ft. 8 in. by 2 ft. 3 in.?

8. How many square yards are there in the walls and the ceiling of a room 21 feet long, 18 feet wide, 12 feet high?

9. A tank $5\frac{1}{2}$ feet by 6 feet by 7 feet can be emptied by two pipes, one of which discharges 9 gallons per minute and the other 7 gallons per minute. How long will it take each to empty the tank? How long will it take both together?

10. A parlor is 18 feet long, 15 feet wide. Make a diagram, showing how carpet 27 inches wide can be laid without cutting the carpet lengthwise. Which would be the better way to lay carpet 30 inches wide in the above room?

11. Calculate the number of running yards of carpet 30 inches wide needed for the floor of the above room, including $4\frac{1}{2}$ yards wasted in matching the pattern.

Find the cost of carpeting the room at 95 cents per running yard for carpet, 5 cents per square yard for lining, and 10 cents per running yard for sewing and laying.

12. A room is 18 feet wide, 24 feet long, and 9 feet high. There are two doors 4 feet wide, $7\frac{1}{2}$ feet high; two windows 4 feet wide, 6 feet high; and a fireplace 5 feet square. How many square feet of plastering will there be on the walls

and ceiling, deducting for a baseboard 12 inches wide? How many running feet of baseboard will be needed?

Draw "development" of the above room, showing the four walls and the ceiling, and locating the doors, the windows, and the baseboard.

Do not use baseboard where it is not required.

13. At the rate of \$1400 for a pile of lumber 25 feet long, 20 feet wide, 10 feet high, what is the value of a pile 50 feet long, 40 feet wide, 20 feet high?

14. If it costs \$14 to paint the walls and the ceiling of a room 25 feet long, 20 feet wide, and 10 feet high, what will it cost to paint the walls and the ceiling of a room 50 feet long, 40 feet wide, and 20 feet high?

15. Measure accurately the interior dimensions of a quart or a pint cup, and calculate its volume.

NOTE.—How many cubic inches in a quart, liquid measure?

462. Circular Measure.

60 seconds ('")	1 minute (').
60 minutes	1 degree ($^{\circ}$).
360 degrees	1 circle.

16. If the equatorial circumference of the earth is 25,000 miles, how many miles apart are two places on the equator, the distance between them being 20° ?

$$20^{\circ} = \frac{1}{18} \text{ circle.}$$

17. What is the length of a degree on a circle whose diameter is 18 feet?

18. The 60th parallel of latitude is a circle one-half as long as the equator. How many miles due east of Christiania is St. Petersburg, both situated on this parallel, the former being 10° east of Greenwich, and the latter 30° east?

LONGITUDE AND SOLAR TIME.

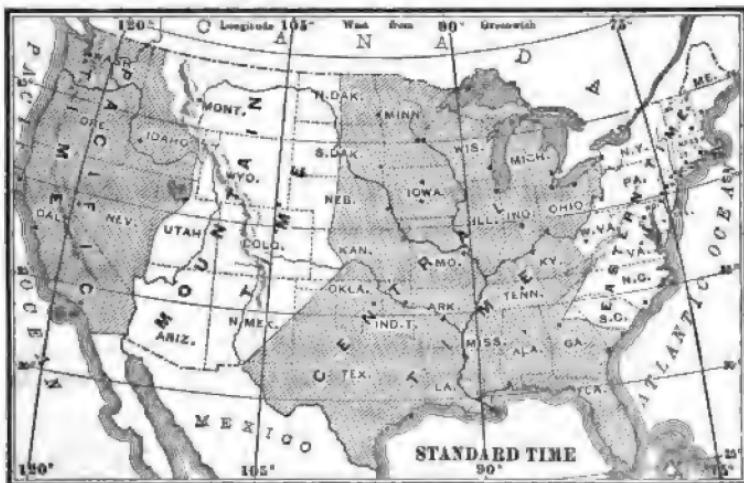
NOTE.—This topic should be taught in connection with the study of Mathematical Geography. The globe should be used to show the pupils that all places on the same meridian have the same solar time, that a difference in longitude of 15 degrees produces a difference in time of 1 hour, and that the more easterly of two places has the later time.

463. Preliminary Exercises.

1. The difference in time being 1 hour for each 15 degrees, find the difference in longitude between two cities differing in solar time 3 hours.
2. Two places differ in longitude 60 degrees. What is their difference in solar time?
3. London is 75° east of Philadelphia. When it is 1 o'clock at Philadelphia, what is the time at London?
4. When it is 2 P.M. at London, what is the time at Philadelphia?
5. How many degrees of longitude correspond to a difference of 3 hr., 40 min. in solar time?
6. What is the difference in longitude between Philadelphia, 75° west longitude, and St. Petersburg, 30° east longitude?
7. Washington is in 77° west longitude, and uses "standard time," that is, the time of 75° west longitude. What is the difference between the correct time at Washington and its clock time?
8. A town in 84° west longitude uses standard time, that of 90. What is the correct time when the clocks are striking 12, noon?
9. Chicago is $87^{\circ} 35'$ west of Greenwich. Is it earlier or later than noon at Chicago when it is noon at Greenwich? Why?

STANDARD TIME.

464. In 1883, the railroads of the United States adopted a system of dividing the country into four time sections, each of 15° longitude. The 75th meridian west of Greenwich, which passes between New York and Philadelphia, was selected as the starting-point. The section governed by the time of this meridian, called *eastern time*, included the territory between the Atlantic coast and a line drawn through Detroit, Pittsburg, Wheeling, Parkersburg, Hunt-



ington, Bristol, Tenn., Augusta, Ga., and Charleston, these cities being the termini of important railroads. *Central time* is governed by the time of the 90th meridian, and is used by the section west of Detroit, etc., to Bismarck, North Platte, Dodge City, etc. The next section which takes the time of the 105th meridian, called *mountain time*, extends to Helena, Ogden, and the western boundary of Arizona. The rest of the country to the Pacific Ocean takes the time of the 120th meridian, called *Pacific time*.

SOLAR TIME.**465. Written Exercises.**

1. Find the difference between the sun time of London and that of Chicago, longitude $87^{\circ} 35'$ west of London.

A difference of 15 degrees of longitude makes a difference of 1 hour; of 15 minutes of longitude, a difference of 1 minute; of 15 seconds of longitude, a difference of 1 second.

If 1 degree of longitude made a time difference of 1 hour, the difference in time between London and Chicago would be 87 hr. 35 min.; as it takes 15 degrees to make a difference of an hour, the difference of time between London and Chicago is $\frac{1}{15}$ of 87 hr. 35 min. Dividing, therefore, 87 hr. 35 min. by 15, we get the time difference as 5 hr. 50 min. 20 sec.

To find the time difference, divide the longitude difference expressed as hours, minutes, and seconds, by 15.

2. When it is midnight at London, what is the sun time at Chicago?

Since the more easterly place has the later time, it is 5 hr. 50 min. 20 sec. before midnight at Chicago. 12 hr. (P.M.) - 5 hr. 50 min. 20 sec. = 6 hr. 9 min. 40 sec. P.M. *Ans.*

3. Two places differ in longitude $37^{\circ} 18'$. What is their difference in solar time?

4. Find the difference in longitude between two places differing in solar time 3 hr. 44 min.

Multiply $8^{\circ} 44'$ by 15.

To find the longitude difference, multiply by 15 the time difference expressed as degrees, minutes, and seconds.

5. Find the difference in sun time between two places in longitude $74^{\circ} 31'$ and $93^{\circ} 14'$ west of Greenwich, respectively.

6. When it is noon at a place 11° east of Greenwich, it is 1:30 P.M. at another place. Find the longitude of the latter place.

NOTE. — Owing to the general use of standard time by civilized countries, problems in longitude and time have no practical value except for navigators. The following problems should be worked only after more important topics have been completed.

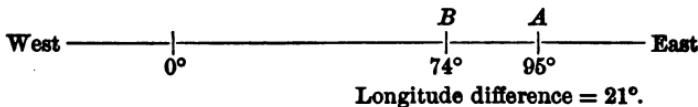
NOTE. — The word "time" in the following problems means "mean solar time."

7. Given the longitude of *A* as 95° east, and that of *B* as 74° east, and the time at *A* as 1:30 P.M., to find the time at *B*.

Since the latitude of *B* has no bearing upon its time, both places may be located upon the same line running east and west.

$$\text{Time difference} = ? \text{ hours.}$$

$$\text{Time} = ? \quad \text{Time } 1:30 \text{ P.M.}$$



Locate the prime meridian (that of 0°), then the meridians of 74° and 95° east. Mark above the last two the names of the places, *B* and *A*. Write above *A* its given time, 1:30 P.M.

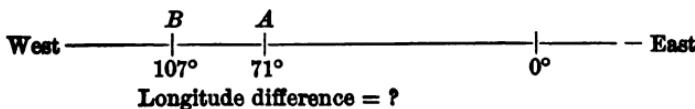
To find the time at *B*, we must find the difference of time between *B* and *A*. The difference in longitude is $95^{\circ} - 74^{\circ} = 21^{\circ}$. The difference in time is 21 hours + 15.

NOTE. — Remember that the more easterly of the two places has the later time.

8. *A* is situated in 71° west longitude, *B* in 107° west longitude. What time is it at *B*, when it is noon at *A*?

$$\text{Time difference} = ?$$

$$\text{Time? } 12 \text{ M.}$$

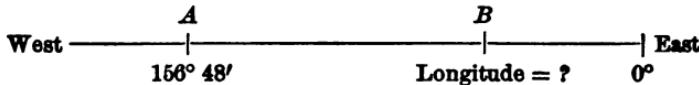


9. Find the longitude of *B*, whose time is 8:10:30 A.M., when it is 7:15 A.M. at *A*, whose longitude is $156^{\circ} 48'$ west.

Time difference = ?

7:15 A.M.

8:10:30 A.M.



Longitude difference = ?

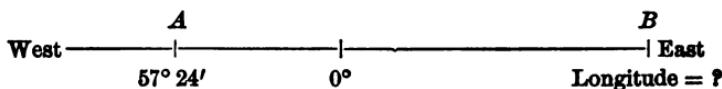
Since *B* has the later time, its location is east of *A*. The difference in time, being nearly an hour, shows the difference in longitude to be nearly 15° . Find the exact difference. Is it to be added to $156^{\circ} 48'$ or subtracted from it, to give the longitude of *B*?

10. When it is 2:40 A.M. at *A*, in $57^{\circ} 24'$ west longitude, it is 10 A.M. at *B*. Find the longitude of *B*.

Time difference = $7\frac{1}{2}$ hours.

2:40 A.M.

10 A.M.



Longitude difference = $15^{\circ} \times 7\frac{1}{2} = 110^{\circ}$.

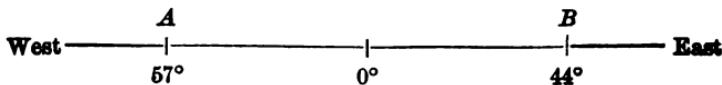
If we go 110° eastward from *A*, we shall reach the prime meridian after going how many degrees and minutes? How many more degrees and minutes must we travel to reach *B*? Is *B* in east or in west longitude?

11. When it is noon at *B*, what is the time at *A*, the former being in longitude 44° east, and the latter in longitude 57° west?

Time difference = ?

Time = ?

12 M.



Longitude difference = 101° . Why?

Find the longitude or the time:

Longitude of A.	Time at A.	Longitude of B.	Time at B.
12. 63° east	9 A.M.	54° east	?
13. $57^{\circ} 25'$ east	?	$83^{\circ} 20'$ east	1:45 P.M.
14. $156^{\circ} 48'$ west	3:15 P.M.	?	4:10 P.M.
15. ?	11:42 A.M.	$56^{\circ} 25'$ west	1:27 P.M.
16. $2^{\circ} 15'$ west	6:53 A.M.	$67^{\circ} 48'$ east	?
17. $27^{\circ} 10'$ east	?	$27^{\circ} 10'$ west	12 M.
18. ?	4:10 P.M.	$18^{\circ} 4'$ east	11:30 A.M.
19. $74^{\circ} 56'$ west	3:50 A.M.	?	11 A.M.
20. $4' 30''$ east	8:47 A.M.	$90^{\circ} 15'$ west	?
21. ?	10:30 P.M.	$32^{\circ} 30'$ east	6:48 P.M.

REVIEW.

466. Oral Problems.

- At what per cent will \$12, in 3 yr. 4 mo., amount to \$14?
- What will be the cost of a building lot 100 feet long and 50 feet wide at 50¢ a square foot?
- A horse was sold for \$90, at which price $12\frac{1}{2}\%$ was gained. What per cent would have been gained by selling him for \$100?
- What is the premium for insuring \$6000 on my house at $1\frac{1}{4}\%$?
- How many cubic inches in a ten-inch cube?
- Bought 2 chairs at \$1.25, one wash-tub for \$1.50, 1 table for \$3.00, and 5 dozen glasses at 48¢ a dozen. Gave a ten-dollar bill in payment. How much change did I receive?

7. My desk is $1\frac{1}{2}$ feet long, and 1 foot wide. How many inches around it?

8. If a man spends 50¢ a day during April, May, and June, what does he spend in the three months?

9. A grocer bought 15 barrels of flour at \$5 a barrel. At what price must he sell them to gain \$36?

10. Seven-eighths of James's vacation will be equal to seven-ninths of yours; yours will be 63 days. How many will his be?

11. A man sold two cows for \$30 each. On one he gained 25%; on the other he lost 25%. Did he gain or lose, and how much?

12. What principal, in three years and 4 months, at 6%, will give \$40 interest?

NOTE.—To the following ten problems the wrong answers are very frequently given.

13. Sold a horse for \$250, losing \$50. What is the loss per cent?

14. If 3 boys solve 3 problems in 3 minutes, how long will it take 6 boys to solve 6 problems?

15. Two boys go fishing; one brings 7 cakes for lunch, the other brings 5 cakes. A third boy joins them at noon, and pays 12¢ for his share of the meal. How should the first two divide the money received?

16. If 100 per cent is gained by selling an article for \$1, how much would be gained by selling it for \$2?

17. A boy had a slate 5 inches by 7 inches. He buys one twice as large. Give the dimensions of the new slate.

18. A man wishes to put up on the front of his lot a fence 30 feet long. If the posts are 6 feet apart, how much will they cost at 25¢ each?

19. One-half the money taken in by a newsboy is profit. What per cent does he make?

20. 50 per cent of a number multiplied by 30 per cent of the same number equals 60. What is the number?

21. Three-fourths per cent of a number is 90. What is the number?

22. An importer receives some cases of goods numbered consecutively. How many cases are there, if the number of the first is 28, and of the last 75?

467. Written Problems.

1. What is the profit on 9 boxes of oranges, each containing 20 dozen, bought at \$1.10 per hundred and sold at the rate of 18 for 25¢?

2. How long will it take a train to go 176 miles at the rate of 3520 feet per minute?

3. If .0375 of an acre of land is worth \$9, what is $\frac{3}{32}$ acre worth?

4. At £1 1s. 7d. per barrel, how many barrels of flour can be bought for £161 17s. 6d.?

5. If 580 tiles, each 6 inches square, will cover a certain area, how many tiles, each 4 inches long and 3 inches wide, will be needed to cover the same area?

6. A man receives \$1500 commission on his yearly sales. What is the amount of his sales if he is allowed $\frac{1}{4}$ per cent commission?

7. At what rate per cent will \$360 produce \$3.06 interest in 2 mo. 12 da.?

8. Find the square root of 25.00400016.

9. What will be the capacity, in gallons, of a tank 9 ft. long, 6 ft. 8 in. wide, and 6 ft. 5 in. deep?

10. What decimal multiplied by 312.5 will give the sum of $\frac{5}{8}$, $\frac{7}{16}$, $\frac{3}{4}$, .09375, and 2.46?

11. A dealer bought a lot of coal \$ 4.95 per ton. What was the total cost if he gained \$ 142.50 by selling it at \$ 5.25 per ton?

12. Find the value of $\frac{2\frac{1}{4} + 4\frac{5}{12}}{1\frac{3}{4} \times 3} - \frac{1}{6}$ of 64.

13. The front wheel of a wagon measures 13 feet in circumference. What is the distance travelled in miles, rods, yards, etc., when the wheel has made 527 revolutions?

14. Write in words .349, 300.049, $\frac{840}{9999}$, 300 $\frac{48}{999}$.

15. If a bar of silver weighing 4 lb. 6 oz. 12 pwt. is worth £ 6 14s. 2d., what is the value (in English money) of a similar bar weighing 7 lb. 9 oz. 12 pwt.?

16. A and B form a partnership. A furnishes \$ 5000; B, \$ 10,000. During the year A draws \$ 1500 of the profits and B draws \$ 1000. At the end of the year the entire business is disposed of for \$ 20,000. What amount should each receive?

17. What per cent is gained on an article bought for 20 per cent less than its value and sold for 20 per cent more than its value?

18. A person loans \$ 750 to M and \$ 1200 to N at the same rate. From the latter he receives half-yearly \$ 9 more interest than from the former. What is the annual rate of interest?

19. A 4-months note for \$ 375, drawn March 19, was discounted at a bank June 4. Find the proceeds. Rate, 6%.

20. M can do a piece of work in 4 days, N can do it in 5 days, O in 6 days. How long will it take the three together to do the work?

$$1 \text{ day} + (\frac{1}{4} + \frac{1}{5} + \frac{1}{6}). \text{ Analyze.}$$

STOCKS.

468. Some undertakings, such as the construction of a railroad, the building and equipment of a factory, the development of a mine, and the like, require more money than any individual may care to risk. It then becomes necessary to secure the coöperation of a number of persons.

The people of a certain town desire to build a street railroad, the construction and equipment of which will require \$50,000. The projectors organize a company. If it is desired to interest people of small means, the required *capital* may be divided into *shares* of \$10 each, making the total number of shares 5000. If the shares are fixed at \$100 each, there will be 500 shares.

To every purchaser of shares, a *certificate* is issued, countersigned by the officers of the company, setting forth the amount of capital, the total number of shares, and the number issued to the holder of the certificate.

At certain fixed periods, quarterly, semi-annually, or annually, the directors of the company determine what part of the profits shall be distributed to the stockholders, the remainder being reserved for new cars, extension of the road, etc. The profits thus distributed are called *dividends*.

469. Written Problems.

1. A company is organized with a capital of \$50,000, divided into shares of \$100 each. What part of the stock is held by the owner of 10 shares?

2. If dividends of \$2000 are distributed at the end of six months, how much should the holder of 10 shares receive?

3. The company announces the dividend as a certain per cent of the capital. What per cent dividend is declared in this case? To what per cent per year is it equal?

4. Mr. H. has \$4500 in the savings bank, on which he receives 4 per cent interest. He gives this amount for 30 shares of the stock. What price does he pay per share? What per cent of the par value?

5. If the next semi-annual dividend is 4%, how much more income does Mr. H. receive from the stock than he would obtain from the savings bank?

6. What per cent has Mr. H. received for six months on his investment of \$4500?

7. If Mr. H. sells the 30 shares at \$164.50 per share, how much more does he receive for it than it cost him?

470. Stocks are generally bought and sold by brokers, who charge, as a rule, $\frac{1}{2}\%$ of the par value for buying or for selling. The prices of the stocks as given in the newspapers are generally a percentage of the par value. Thus, the New York quotation of Pennsylvania R.R. on March 4, 1903, is $151\frac{1}{2}$. This means that the shares of the Pennsylvania R.R. sold for $\$50 \times 1.51\frac{1}{2}$, or \$75.75, the par value being \$50. The Philadelphia papers of the same date, however, quote the stock at $75\frac{1}{2}$, it being the practice in that city to give the price per share.

471. Written Exercises.

1. Find the cost of 240 shares Anaconda Copper Mining Co., par value \$25, at $134\frac{1}{2}$, brokerage $\frac{1}{2}\%$.

$$\text{Cost} = \$25 \times 240 \times (1.34\frac{1}{2} + .00\frac{1}{2}).$$

To find the cost, multiply the face value of the given number of shares by the rate plus the brokerage.

2. How much brokerage is paid by the buyer of 275 shares bank stock, par value \$100, brokerage $\frac{1}{2}\%$?

$$\frac{1}{2}\% \text{ of } \$100 \times 275.$$

3. Paid \$11,445 for 120 shares Cleveland, Cincinnati, Chicago, & St. Louis, par value \$100, brokerage $\frac{1}{2}\%$. What was the value of the stock per share?

The brokerage on 120 shares, par value \$100, is $\frac{1}{2}\%$ of \$12,000, or \$15. The cost of the stock is, therefore, \$11,480. Dividing by the number of shares gives the value per share.

$$(\$11,445 - \frac{1}{2}\% \text{ of } [\$100 \times 120]) \div 120.$$

4. Bought 150 shares Evansville and Terre Haute at \$69 $\frac{1}{2}$, brokerage $\frac{1}{2}\%$, paying for it \$5212.50. What is the par value per share?

The cost of each share is \$5212.50 \div 150. Divide this cost by the rate, including the brokerage, .69 $\frac{1}{2}$ + .00 $\frac{1}{2}$.

$$(\$5212.50 \div 150) \div (.69\frac{1}{2} + .00\frac{1}{2}).$$

5. A broker sells for a customer 200 shares stock, par value \$25, at 102 $\frac{1}{4}$. If he retains $\frac{1}{2}\%$ brokerage, how much does he pay over to the former owner of the stock?

6. A man buys 60 shares bank stock, par value \$100, at \$450, no brokerage. If the annual dividend is 18%, what is his income therefrom? What per cent does he receive on his investment?

Note. — Dividends are based upon the par value.

7. A manufacturing corporation makes \$20,000 a year over all expenses. The stock consists of 4000 shares, par value \$50. What rate of dividend can be declared?

What per cent on his investment does a man receive who has bought his stock at 175, no brokerage?

8. A capitalist bought 360 shares stock, par value \$25, at 168 $\frac{1}{2}$. He paid therefor, including brokerage, \$15,176.25. What was the rate of brokerage?

9. A broker sold 250 shares, par value \$100, at 107 $\frac{1}{4}$. He deducted brokerage and paid over the proceeds, amounting to \$26,875. Find the amount of the brokerage and the rate per cent.

10. A woman invests \$35,050 in stock at 175, brokerage $\frac{1}{4}\%$. If the annual dividends are $7\frac{1}{2}\%$, what is her income from the investment?

11. Which investment will pay better, one in a gas company paying 6% dividends annually, their stock selling at 150, the other in a bank paying 7% dividends annually, stock selling at 175?

12. What annual dividend should be declared on railroad stock bought at 125, so that the buyer will receive 4% per annum on his investment? What semi-annual dividend?

13. What will be the cost of 17 shares of canal stock, par value \$50, at $93\frac{1}{4}$, and 143 shares gas stock, par value \$10, at $102\frac{1}{4}$?

NOTE. — An examination of the prices of stocks as given in the newspapers will show that the rate of dividends constitutes but one consideration influencing buyers. The following prices were offered March 4, 1903, for stocks of four banks, respectively, each of which paid 6 per cent dividends annually; 185, 245, 390, 685. Purchasers of shares of the last three banks evidently hoped for larger dividends in the immediate future.

The values of bonds depend in the first instance upon the character of the corporation issuing them, then upon the rate of interest and the length of time before redemption. United States bonds bring the highest prices, as buyers have no fear of the failure of the government to keep its promises. The following are the prices obtained at the last sales reported to March, 1903:

Rate.	Date of		
	Redemption.	Price Paid.	Last Sale.
U. S. 2's	1930	108 $\frac{1}{4}$	Nov. 14, 1902
U. S. 4's	1907	110 $\frac{1}{2}$	Feb. 4, 1903
U. S. 4's	1925	136	Feb. 26, 1903
U. S. 5's	1904	103	Feb. 23, 1903

The 5 per cent bonds, although bearing the highest rate of interest, bring only 103, as they will be redeemed at par a little more than a year after they are bought. The purchaser, who paid \$103 for a bond, will receive for it in 1904 only \$100, with about \$5 interest, his net profit for the year being \$2 on an investment of \$103.

BONDS.

472. A *bond* is a form of interest-bearing note issued by a corporation.

A *coupon* bond is one containing certificates of interest which are cut off and presented for payment as interest becomes due. A 10 years' U. S. coupon bond has 40 coupons, one for each quarter-year's interest. Upon each is engraved the date when due, and the sum payable, which is \$10 in the case of a \$1000 four-per-cent bond.

A *registered* bond contains no coupons, a check for the interest being mailed to the owner, whose name is registered on the books of the corporation.

473. Written Exercises.

1. A railroad company needing more money to extend its road, issues bonds bearing interest at 4%. If these bonds are sold at 95, what rate of interest on the money invested does the owner of a bond receive?

For each \$95 invested the owner receives \$4 interest. The rate is $4 + .95$.

To find the rate on the investment, divide the rate of interest by the rate paid for the bond, including brokerage, if any.

2. Find the cost of 20 one thousand dollar bonds at $120\frac{1}{2}$, brokerage $\frac{1}{8}\%$.

3. If the foregoing bonds bear interest at the rate of 6%, what is the annual income? What rate per cent annually is received on the sum invested?

4. A man desires to secure an annual income of \$650 for his daughter. What is the face value of 5% bonds necessary to produce this income? What will be the cost of 5% bonds of Denver & Rio Grande at 107, brokerage $\frac{1}{8}\%$?

5. A person desirous of obtaining a semi-annual income of \$900 is offered Central Pacific 4's at $99\frac{1}{4}$, Chicago & Alton 3's at $83\frac{1}{4}$, or Western Union 4½'s at $104\frac{5}{8}$, no brokerage in any case. Find the difference between the smallest and the largest outlay necessary to secure the desired income from these bonds.

NOTE. — 4's means bonds paying 4 per cent interest per year.

6. How much money must be invested in the U. S. 2's to yield a quarterly income of \$225, bonds selling at $108\frac{1}{4}$, brokerage $\frac{1}{8}\%$?

7. An owner of 6 per cent bonds sells them at the market quotation of 118, and invests the proceeds in 4½ per cent bonds. The latter investment yields him the same income as the former. What did he pay per hundred for the 4½ per cent bonds, no brokerage?

8. A, having a farm of 109 acres, which rents for \$681.25 above taxes, etc., sells the same for \$200 per acre, and invests the proceeds in U. S. 2's @ $108\frac{1}{8}\%$, brokerage $\frac{1}{8}\%$. Will his yearly income be increased or diminished, and how much?

9. What is the difference in the rate of income obtained from an investment in U. S. 2's at $109\frac{1}{4}$, and one in U. S. 4's at $137\frac{5}{8}$, brokerage $\frac{1}{8}\%$ in each case?

NOTE. — In calculating the rate of interest in the foregoing examples, the time of the redemption of the bonds is omitted from consideration. In the following example, however, the term of the bond is made an element in the computation. The holder of it has received \$30 in interest, and he is paid \$100 for the bond. Ignoring the matter of compound interest, the question becomes: At what rate will \$104 amount in 6 years to \$130?

10. Mr. Tower pays \$104 for a \$100 five per cent bond. At the end of six years the bond is redeemed at par. What rate of interest does he receive on his investment of \$104?

DOMESTIC EXCHANGE.

474. Arthur S. Somers, of Memphis, Tenn., wishes to pay John R. Thompson, of The City of New York, \$ 3475.86. If Mr. Somers sends a check, drawn on his Memphis bank, Mr. Thompson will be charged a certain sum by his New York bank for collecting the amount of the check, and he will thus receive somewhat less than the sum due him. Mr. Somers, therefore, buys from J. E. Washington, a Memphis banker, who has funds in a New York bank, the following

SIGHT DRAFT.

\$ 3475 $\frac{86}{100}$.

MEMPHIS, TENN., Aug. 9, 1904.

At sight, pay to the order of John R. Thompson Three Thousand Four Hundred Seventy-five $\frac{86}{100}$ Dollars, value received, and charge to the account of

To Chemical Bank,
The City of New York.

JOSEPH E. WASHINGTON.

Mr. Somers is charged for this draft a premium of \$ 1.50 per \$ 1000; that is, he pays Mr. Washington \$ 1001.50 for each \$ 1000. The cost of the draft is, therefore, \$ 3475.86 $\times 1.0015$, or \$ 3481.07.

475. Exchange is at a *premium* when the cost of a sight draft is greater than its face; it is at a *discount* when the cost of a sight draft is less than its face.

476. Mr. Thompson could collect the sum due him by making a draft on Mr. Somers as follows:

TIME DRAFT.

\$ 3475 $\frac{86}{100}$.

NEW YORK, Aug. 9, 1904.

At three days' sight pay to the order of The National Bank of Commerce Three Thousand Four Hundred Seventy-five and $\frac{86}{100}$ dollars, value received, and charge to the account of

JOHN R. THOMPSON.

To Arthur S. Somers,
Memphis, Tenn.

Mr. Thompson deposits the draft in the National Bank of Commerce for collection. This bank forwards it to a Memphis bank. The latter notifies Mr. Somers. If he wishes to pay the draft at the expiration of three days, he writes across the face in red ink, "Accepted," with the date, "Aug. 11, 1904," and adds his signature. Aug. 14 he pays the money to the Memphis bank, which notifies the Bank of Commerce, and the sum is placed to the credit of Mr. Thompson, less the cost of collection.

477. A *sight* draft is payable upon presentation, except in those states allowing "days of grace." A *time* draft is one payable a specified number of days after acceptance. In some states three additional "days of grace" are allowed.

478. Written Exercises.

1. Find the cost of a Boston draft on New York for \$1875, at 12¢ discount per \$1000.

Face	\$ 1875.
Discount \$ 1875 × .00012	<u>.225</u>

Ans. \$ 1874.775.

To find the cost of a sight draft, add the premium to the face, or subtract the discount from the face.

2. What will a St. Louis merchant pay for a draft on New York for \$2460.53, at 50¢ premium per \$1000?

3. At $\frac{1}{8}\%$ premium, find the cost of a sight draft for \$1843.60.

4. At 75¢ discount per \$1000, how much will cost a sight draft on Milwaukee for \$946.75?

5. Paid \$632.18 for a sight draft on Milwaukee. What was the face of the draft, the discount being $\frac{8}{40}\%$?

BILLS OF EXCHANGE.

479. Bills of exchange are either domestic or foreign. A domestic bill of exchange is called a *draft*, the term *bill of exchange* being generally applied only to foreign bills.

480. Fred Johnston owes John Ahern & Co., of London, £ 180 17s. 6d. He buys from John Cottier & Brother a bill of exchange drawn on their London correspondent. The bill is drawn in duplicate, one being sent by Mr. Johnston to John Ahern & Co., and the other being retained by the former to send in case of the loss of the first. When either is paid the other becomes of no value.

The following is the form of the first of a set of exchange.

Exchange for £ 180 17s. 6d. NEW YORK, Dec. 14, 1903.

Sixty days after sight of this First of Exchange (Second unpaid), pay to the order of John Ahern & Co., One Hundred Eighty Pounds Sterling, Seventeen Shillings Six Pence, value received, and charge the same to account of

To James Lennon & Co., JOHN COTTIER & BROTHER.

London.

No. 39.

Upon receipt of this bill, John Ahern & Co. present it for acceptance. They receive the money sixty days thereafter.

481. Written Exercises.

- Find the cost of the above bill at \$4.87 per pound.

$$\text{£} 200 = \$ 974.00$$

$$20 = \underline{\hspace{2cm}} 97.40$$

$$\text{£} 180 = \$$$

$$10s. = 2.435 \text{ £} \frac{1}{2}$$

$$5s. =$$

$$2s. 6d. = \underline{\hspace{2cm}}$$



2. What is the cost of a cable transfer of £ 251 11s. 9d., at \$4.88 $\frac{1}{2}$ per pound?

$$\text{£} 250 = \$1221.25 \quad \frac{1}{2} \text{ of } \text{£} 1000$$

$$1 =$$

$$10s. =$$

$$1s. =$$

$$6d. =$$

$$3d. =$$

The newspapers give quotations of foreign exchange for sight and 60-day bills, also for cable transfers.

482. The New York quotations for French exchange give the number of francs for \$1.

Paris cable transfers 5.16 $\frac{1}{4}$ @ 5.15 $\frac{1}{4}$.

Paris bankers' 60 days 5.18 $\frac{1}{4}$ @ 5.18 $\frac{1}{4}$.

Paris bankers' sight 5.16 $\frac{1}{4}$ @ 5.16 $\frac{1}{4}$.

The quotations for German exchange give the value in U. S. money of 4 Reichmarks (or marks).

Reichmarks (4) 60 days 95 $\frac{1}{4}$ @ 95 $\frac{1}{4}$.

Reichmarks (4) sight 95 $\frac{1}{4}$ @ 95 $\frac{1}{4}$.

3. Find the cost of a sight bill on Paris for 1000 francs, at 5.16 $\frac{1}{4}$ francs for \$1.

4. Find the cost of a 60-day bill of exchange on Berlin for 1874.35 marks, at 95 $\frac{1}{4}$ ¢ for 4 marks.

5. What will be the face in marks of a sight bill of exchange on Berlin that can be bought for \$1000, at 95 $\frac{1}{4}$ ¢ for 4 marks?

6. A New York merchant pays \$1637.50 for a 60-day bill on Paris. What is the face of the bill, the rate of exchange being 5.18 $\frac{1}{4}$ francs for \$1?

7. At \$4.88 per pound, what will be the face of the sight bill on London that can be bought for \$1500?

$$\begin{array}{r} 18750 \\ \underline{1500.00} = 18750 \\ 4.88 \\ \hline 61 \\ \hline \end{array} \qquad \begin{array}{r} \text{£} 807 7s., \text{etc.} \\ 61) \underline{18750} \\ \underline{450} \\ \underline{\text{£} 23 \text{ remainder}} \\ 20 \\ \hline 460s., \text{new dividend} \end{array}$$

8. Bought goods in London amounting to £437 5s. 10d. less 4%. How much do I pay in Boston for a sight bill of exchange at \$4.88½ to settle the account?

9. What will be the cost in Chicago for a 60-day bill on Paris that will pay for the following articles? Rate, 1 franc = 19½¢.

18 pieces silk, 44 meters each, at 25 francs per meter, less 7½%.

3 pieces of cloth, 50 meters each, at 20 francs per meter, less 5%.

Packing charges, 60.50 francs.

10. I wish to send a sight bill of exchange on Berlin in payment of the following invoice:

4 cases musical instruments, amounting to 3598.60 marks, less 10, 5, and 2½%.

Freight to Hamburg, 165 kilos, at 4.80 marks per kilo.

At 95½¢ for 4 marks, what will be the cost of the bill of exchange?

11. If the rate of exchange is 50¢ discount per \$1000, what is the face of the sight draft on Boston, that can be bought in New York for \$1000?

NOTE.—\$999.50 in New York will buy a sight draft on Boston for \$1000.

12. When the premium is \$1.25 per \$1000, Mr. Brown pays \$1634.04 for a draft on Louisville. What is the face of the draft?

COMPOUND INTEREST.

483. Compound Interest is interest on the principal and on the unpaid interest, which is added to the principal at regular intervals. The interest may be compounded annually, semi-annually, or quarterly, according to agreement.

Compound interest is allowed by savings banks. It is not collectible on notes, mortgages, or the like.

484. Written Exercises.

1. Find the amount of \$375, for 1 year, at 6%. Considering this as a new principal, find the amount for a year, same rate. Find the amount of this last principal for 3 months.

2. What is the amount of \$375, for 2 yr. 3 mo., at 6%, compound interest?

3. What is the amount of \$375, for 2 yr. 3 mo., at 6%, the interest compounded semi-annually?

Principal, \$375.

$8\% \underline{11.25} \quad 6 \text{ months' interest.}$

$386.25 \quad \text{Amount 6 months.}$

$3\% \underline{11.5875} \quad 6 \text{ months' interest.}$

$\quad \quad \quad \text{Amount 1 year,}$

$3\% \underline{\quad \quad \quad} \quad 6 \text{ months' interest.}$

$\quad \quad \quad \text{Amount } 1\frac{1}{2} \text{ years.}$

etc., etc., etc.

4. Find the compound interest on \$375, for 2 yr. 3 mo., at 6 per cent, compounded semi-annually.

NOTE.—To find the *compound interest*, deduct \$375 from the *amount* for 2 yr. 3 mo.

5. What is the amount of \$100, at compound interest, for 3 years, interest at 6%, compounded annually?

ANNUAL INTEREST.

When the maker of a note fails to keep his contract to pay interest annually, the laws of some states, including Michigan, permit the collection of *simple interest* on the deferred payments of interest.

485. Written Problems.

1. Find the amount due June 1, 1908, on the following note, no payments of principal or interest having been made:

DETROIT, MICH., June 1, 1904.

Four years after date, without days of grace, I promise to pay to the order of Daniel W. Lawler, Six Hundred Dollars, value received, with annual interest at six per cent.

$\$600\frac{00}{100}$.

GEORGE OXNARD.

Principal,	\$ 600.00
Interest, 4 years, at 6 %,	144.00
3 years' interest, at 6 %, on the 1st year's interest, \$ 36,	6.48
2 years' interest, at 6 %, on the 2d year's interest, \$ 36,	
1 year's interest, at 6 %, on the 3d year's interest, \$ 36,	
Amount due June 1, 1910,	\$

Find the interest on the principal for the entire time, and on each annual interest for the time it remained unpaid. The sum of the principal and all the interest is the amount due.

2. Find the amount due, at 5%, for 5 years, on a note for \$ 1200, annual interest being unpaid.

3. The maker of a note for \$ 900, with annual interest at 7%, makes the first and the second interest payments when due. How much will he owe at settlement, 6 years after the date of the note?

4. Find the difference between the amount due at 6% for 3 years on a note for \$ 300, annual interest unpaid, and the amount of the same sum placed at compound interest for the same time at the same rate.

5. What is the amount of a note for \$720, at 4 years, at $4\frac{1}{2}\%$, annual interest unpaid after the first year?

6. Find the amount due March 1, 1906, on a note for \$500, dated March 1, 1900, with interest at 6%, annual interest unpaid after the third year.

METRIC SYSTEM.

486. The metric system, which is used in nearly all the countries of continental Europe, is based upon the meter. The length of the meter is one ten-millionth part of the length of the meridian from the equator to the poles—about 39.37 inches.

The subdivisions of the meter are denoted by the Latin prefixes milli ($\frac{1}{1000}$), centi ($\frac{1}{100}$), deci ($\frac{1}{10}$). For the multiples, the Greek prefixes deka (10), hecto (100), kilo (1000), and myria (10,000) are used.

487. It will be noticed, in the table below, that small letters are used for the abbreviations of the Latin prefixes of the subdivisions, and capital letters for the Greek prefixes of the multiples. The following is the table of

488. Measures of Length.

10 millimeters (mm)	1 centimeter (cm)
10 centimeters	1 decimeter (dm)
10 decimeters	1 <i>meter</i> (m)
10 <i>meters</i>	1 dekameter (Dm)
10 dekameters	1 hectometer (Hm)
10 hectometers	1 kilometer (Km)
10 kilometers	1 myriameter (Mm)

The units of this table in common use are the centimeter, the meter, and the kilometer.

Long distances are expressed in kilometers. The thickness of wire is given in millimeters.

489. Written Problems.

1. What will be the cost in francs of 380 m 75 of dress goods at 2 f 60 per meter?

380 m 75 is read 380 meters 75 centimeters. It is also written 380.75 m, but the first method is the more common one in Europe. 2 f 60 is read 2 francs 60 centimes. A period (.) is not used after the abbreviations of meter, liter, franc, etc.

2. How many square meters in a piece of carpet 26 m 50 long, 85 cm wide?

3. How many square meters in a circle whose diameter is 15 meters?

4. An *are* is a surface 10 meters long, 10 meters wide. How many ares in a field 135 meters long, 69 meters wide?

5. Find the area in ares of a right-angled triangle whose base is 245 meters, hypotenuse 875 meters.

6. A *stere* is a cubic meter. What will be the cost, at 8 f 50 per stere, of a pile of wood 10 meters long, 1 meter wide, 3.25 meters high?

7. A cube one decimeter each way contains a liter (l), which is the principal unit of dry and liquid measure.

How many liters' capacity has a tank 10 m 50 long, 8 m wide, 6 m 50 high?

Change each dimension to decimeters.

8. How many bottles, each containing 0 l 75, can be filled from a hogshead containing 222 l?

9. How much will be received for 36 bags of beans, each containing 68 liters, at 1 mark 25 per dekaliter?

10. A liter of water weighs a kilogram (1000 grams). How many kilos of oil would a tank contain, its dimensions being 5 meters by 4 meters by 3 meters, the weight of the oil being 92% of the weight of water?

11. Assuming the length of the meter as 39.37 inches, what is the length of the kilometer in yards?

490. Measures of Surface.

100 sq. mm = 1 sq. cm

100 sq. cm = 1 sq. dm

100 sq. dm = 1 sq. m = 1.196 sq. yd.

491. The square meter is the principal unit of surfaces, such as walls, ceilings, floors, etc.

100 centiares (ca) = 1 are (a) = 119.6 sq. yd.

100 acres = 1 hectare (Ha) = 2.47 acres.

The are is the principal unit of surface of small plots of land. The area of a farm is expressed in hectares, of a country in square kilometers.

492. Measures of Volume.

1000 cu. mm = 1 cu. cm

1000 cu. cm = 1 cu. dm

1000 cu. dm = 1 cu. m = 35.316 cu. ft.

The principal unit is the cubic meter.

493. The stere (cubic meter) is used for measuring wood.

10 decisteres (dst) = 1 stere (st) = 35.316 cu. ft.

10 steres = 1 dekastere (Dst).

The stere is the only unit used.

494. Dry and Liquid Measures.

10 milliliters = 1 centiliter.

10 centiliters = 1 deciliter. Dry. Liquid.

10 deciliters = 1 liter (l) = .908 qt. = 1.057 qt.

10 liters = 1 dekaliter = 1.185 pk. = 2.642 gal.

10 dekaliters = 1 hectoliter = 2.837 bu. = 26.417 gal.

10 hectoliters = 1 kiloliter.

10 kiloliters = 1 myrialiter.

The liter and the hectoliter are the principal units.

495. Table of Weight.

10 milligrams (mg)	= 1 centigram.
10 centigrams	= 1 decigram.
10 decigrams	= 1 <i>gram</i> (gr).
10 <i>grams</i>	= 1 dekagram.
10 dekagrams	= 1 hectogram.
10 hectograms	= 1 kilogram (kilo) = 2.2046 lb.
10 kilograms (Kg.)	= 1 myriagram.
10 myriagrams	= 1 quintal.
10 quintals	= 1 tonneau (ton).

The kilo is the ordinary unit. Heavy articles are sold by the tonneau.

496. Written Exercises.

1. The Eiffel tower is 300 meters high. What is its height in feet?
2. The Danube is 2600 kilometers long. Find its length in miles.
3. A bottle filled with water weighs 1.170 kilos; the weight of the bottle is 420 grams. What is the capacity of the bottle in liters?
4. Find the weight in kilos of 15 liters of olive oil, which weighs .915 time as much as water.
5. A rectangular field 123 meters long, and 85.5 meters wide, yielded 13.25 hectoliters of wheat per hectare. The wheat weighed 84.350 kilos per hectoliter and sold for 23.50 francs per 100 kilos. What sum did the crop bring?
6. What will be the cost in francs of papering a room 5 m 42 long, 4 m 18 wide, and 3 m 10 high, at 1 f 20 per square meter?
7. Calculate the expense of building a wall 14 m 50 long, 7 m 80 high, 0 m 22 thick, of bricks 0 m 22 long, 0 m 11 wide, 0 m 06 thick, the bricks costing 58 francs per thousand and the labor, etc., 32 f 80 per cubic meter.

8. Find the profit on a pile of wood 20 meters long, 4 meters wide, 8 meters high, bought at 12 francs per stere, and sold at 4 francs per 100 kilos, the weight of the wood being .42 times the weight of water.

9. A liter of wheat weighs 760 grams. When ground it produces 89 per cent flour and 11 per cent bran. Find the weight of the flour that can be made from the wheat contained in a bin 2 m 60 long, 2 m 40 wide, and 1 m 50 deep. Find the value of the wheat at 4 f 85 per double dekaliter.

10. If sea water contains $\frac{1}{40}$ of its weight of salt, how many hectoliters of sea water should be evaporated to obtain 100 kilos of salt, a liter of sea water weighing 1.026 kilos?

REVIEW.

497. Oral Problems.

1. If $\frac{2}{3}$ yard costs \$4.50, what will $\frac{4}{5}$ yard cost?
2. If 3 men can do a piece of work in 4 days, how long will it take 24 men to do it?
3. What principal at interest for 5 years, at 6 per cent, will produce \$12, simple interest?
4. A stack of hay will keep a cow 20 weeks, or a horse 15 weeks. How long will it keep them both?

Note. — What part will each eat in a week? What part will both eat in a week?

5. How many days from May 16 to July 5?
6. Sold a cow for \$24, losing thereby 40% of the cost price. Had I sold her for $33\frac{1}{3}\%$ advance on the cost, what should I have received for her?
7. What will 460 pounds of tea cost at \$.48 per pound?
8. If 12 ounces of bread are destroyed in making a gill of whiskey, how much will be destroyed in making a gallon?

$$4 \text{ gills} = 1 \text{ pint.}$$

9. If the weight of air is 15 pounds on the square inch, what is it on the square foot?
10. Seven is three-fifths of what number?
11. What is the value of 960 pounds of wheat at \$1.05 per bushel of 60 pounds?
12. At what rate per cent will \$400 make \$37.50, simple interest, in 1 yr. 3 mo.?
13. What is the brokerage on \$10,400, at $1\frac{3}{8}\%$?
14. What will 3280 feet of lumber cost @ \$25 per thousand?
15. A and B are partners; A puts in $\frac{5}{12}$ of the stock, and B the remainder; B's gain is \$1400. Find A's gain.
16. What is the difference in the longitude of two places whose difference in sun time is two hours and three minutes?
17. A room is $\frac{2}{3}$ as wide as it is long. Its length is 20 feet. How many square feet are there in the floor?
18. If 5 yards of cloth cost 90¢, what will $\frac{2}{3}$ of a yard cost?
19. An agent insured a house for me at a commission of $\frac{1}{4}\%$. His commission was \$15. For how much was the house insured?
20. A gold-digger who had 3 pounds of gold dust, lost 9 ounces. What per cent was left?

498. Written Problems.

1. What number must be added to the sum of $\frac{4}{5}$, $\frac{7}{8}$, and $\frac{11}{12}$ to make $5\frac{8}{9}$?
2. Find the interest on \$2320, for 5 months and 21 days, at the rate of 7 per cent a year.
3. Find the interest on \$640, from Sept. 3, 1904, to Oct. 30, 1905, at 6 per cent per annum.

4. At compound interest, what will \$200 amount to in 1 year and 3 months, at 6 per cent, interest compounded semi-annually?

5. A man drew out of the bank $\frac{1}{3}$ of his money, and expended 30% of 50% of this for 936 bushels of wheat at \$0.87 $\frac{1}{2}$ a bushel. What sum had he left in bank?

6. A house that cost \$14,500 rents for \$1189. What per cent does it pay on the investment?

7. If 4 men dig a ditch 24 rods long in 20 days, how long a ditch can 5 men dig in 8 days?

8. For what sum must a 60-day note be written to yield \$294.75 at a bank, discounting at 6%?

9. An agent receives \$5616 for silk he has purchased and his commission on it at 4%. How many yards did he purchase at \$1.50 per yard?

10. What will be the proceeds of a 60-day note for \$500, dated June 4, 1904, and discounted at a bank July 1, 1904, at 6%?

11. At what rate will \$142 gain \$21.30 interest in 3 years?

12. What is the duty, at 50¢ a pound and 30% ad valorem, on 700 yards of French broadcloth, invoiced at \$1.25 per yard, and weighing 1 $\frac{1}{4}$ pounds per yard?

13. What will be the amount, at compound interest, of \$340, at 8%, for 1 yr. 3 mo., the interest compounded semi-annually?

14. If I lose 10% by selling goods at 18¢ a yard, for what must they be sold to gain 20%?

15. I sold 24 $\frac{1}{2}$ % of my estate, or \$1372 worth. I am worth, in addition to my real estate, \$14,000. How much am I worth in all?

REVIEW OF FRACTIONS.

499. Oral Exercises.

Give products :

1. $84 \times 24 = 25$ times $84 - 84 = 2100 - 84$.
2. 48×24 .
3. 24×36 .
4. 48×49 .
5. 84×49 .
6. 84×74 .
7. 48×74 .
8. $84 \times 24\frac{1}{2} = 25$ times $84 - \frac{1}{2}$ of $84 = 2100 - 42$.
9. $48 \times 24\frac{1}{2}$.
10. $36 \times 24\frac{1}{2}$.
11. $48 \times 24\frac{3}{4}$.
12. $36 \times 24\frac{3}{4}$.
13. $48 \times 24\frac{7}{8}$.
14. $36 \times 24\frac{7}{8}$.
15. $48 \times 36\frac{1}{2} = 37\frac{1}{2}$ times $48 - 48 = (\frac{1}{2} \text{ of } 4800) - 48$.
16. $48 \times 11\frac{1}{2}$.
17. $48 \times 86\frac{1}{2}$.
18. $48 \times 37\frac{1}{4}$.

Give quotients :

1. $36 + \frac{1}{4}$.
2. $36 + \frac{3}{4}$.
3. $36 + 2\frac{1}{4}$.
4. $36 + \frac{1}{3}$.
5. $36 + 1\frac{1}{3}$.
6. $36 + 1\frac{1}{2}$.
7. $18\frac{3}{5} + 3$.
8. $20\frac{1}{5} + 4$.
9. $17\frac{1}{2} + 5$.
10. $19\frac{1}{5} + 6$.
11. $16\frac{1}{3} + 7$.
12. $17\frac{1}{3} + 8$.
13. $12\frac{1}{4} + 1\frac{1}{4}$.
14. $16\frac{1}{2} + 1\frac{1}{2}$.
15. $13\frac{1}{3} + 3\frac{1}{3}$.
16. $14\frac{1}{2} + 1\frac{1}{2}$.
17. $15\frac{1}{4} + 2\frac{1}{4}$.
18. $17\frac{1}{2} + 3\frac{1}{2}$.

500. Written Exercises.

Find products :

1. $648 \times \frac{7}{8}$.
2. $976 \times \frac{15}{16}$.
3. $1648 \times 87\frac{1}{2}$.
4. $2592 \times 9\frac{5}{8}$.
5. 2416×875 .
6. 874×99 .
7. 848×125 .
8. 375×999 .
9. 792×25 .
10. 457×16 .
11. 1864×250 .
12. 983×51 .
13. $1576 \times 62\frac{1}{2}$.
14. $176 \times 23\frac{3}{4}$.
15. 1128×875 .
16. $895 \times 44\frac{1}{5}$.

501. Written Exercises.

1. Divide the sum of $6\frac{1}{2}$ and $1\frac{1}{2}$ by the difference between $2\frac{1}{2}$ and $3\frac{1}{2}$.
2. What is the difference between the sum of $\frac{1}{2}$ and $\frac{1}{3}$ and the product of $\frac{1}{2}$ and $\frac{1}{2}$?
3. What is the product of the sum and the difference of $4\frac{1}{4}$ and $6\frac{1}{2}$?
4. Subtract $\frac{1}{2}$ of $\frac{1}{2}$ from $\frac{1}{11}$; and find the value of $\frac{8}{11}$ of 16s. 6d.
5. Add $7\frac{1}{2}$, $\frac{3}{4}$ of $1\frac{1}{2}$, $\frac{1}{2}$ of $7\frac{1}{2}$, and $\frac{1}{2}\frac{1}{2}$.
6. Reduce $\frac{1}{2}$ of a square rod to the fraction of an acre, and find the value of $\frac{7}{16}$ of a ton in pounds and ounces.
7. Reduce $\frac{999}{1805}$ to its lowest terms, and $\frac{3\frac{1}{2} - 2\frac{1}{2}}{3\frac{1}{2} + 2\frac{1}{2}}$ to its simplest form.
8. Add $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, and $\frac{1}{5}$; multiply the sum by $\frac{8}{21}$; and subtract the product from 1.
9. Find the value of $9\frac{1}{11}$ meters at 4s francs per meter.
10. Divide $2\frac{1}{4}$ by $3\frac{1}{2}$, and add the quotient to $1\frac{5}{4}$.
11. Multiply $2\frac{1}{3}$ by $16\frac{1}{2}$, and divide the result by $1\frac{1}{2}$ of $2\frac{3}{4}$.
12. Reduce 7s. 6d. to the fraction of a pound, and 7 hr. 12 min. to the fraction of a day.
13. Reduce to its simplest form $\frac{2 + \frac{1}{2} \text{ of } 5\frac{1}{2}}{\frac{1}{2} \text{ of } \frac{1}{2}}$.
14. Add together £ $\frac{5}{8}$ and $1\frac{1}{10}$ of $5\frac{1}{2}$ shillings.
15. What fractional part of 7 A. 127 sq. rd. is 5 A. 81 sq. rd.?
16. What must be added to $\frac{1}{2}$ of $\frac{1}{2}$ to make it equal to $\frac{9}{10}$ of $3\frac{1}{4}$?
17. $\frac{2}{3}$ of a number is 148. What is the number?
18. If $\frac{1}{2}$ of a field is worth \$325, what is the field worth?
19. If $\frac{1}{3}$ of a house is worth \$4900, what is the value of $\frac{1}{6}$?

REVIEW OF DENOMINATE NUMBERS.

502. Written Exercises.

1. Change 43 yards to rods and a fraction.
2. Change 43 yards to rods and yards.
43 yards + $5\frac{1}{2}$ yards gives the *number* of rods.
3. Change 43 yards to rods, yards, and feet.
4. Change 43 yards to rods, yards, feet, and inches.
5. Change 72 yards to rods, etc.
6. Change 66 yards to rods.

Change to rods, yards, etc.:

- | | |
|--------------------------|----------------------------|
| 7. 49 yards. | 11. 1836 inches. |
| 8. 147 feet. | 12. 1837 inches. |
| 9. 1764 inches. | 13. 52 yards. |
| 10. $8\frac{1}{4}$ rods. | 14. $49\frac{1}{2}$ yards. |

503. Change to rods, etc.:

- | | | |
|------------------|------------------|------------------|
| 15. 1483 inches. | 18. 2796 inches. | 21. 3453 inches. |
| 16. 984 inches. | 19. 1121 inches. | 22. 1278 inches. |
| 17. 1345 inches. | 20. 1470 inches. | 23. 1576 inches. |

504. Add:

- | | |
|---------------------------------|-----------------------|
| 24. 4 rd. 3 yd. 1 ft. | 25. 5 rd. 4 yd. 2 ft. |
| 9 rd. 4 yd. 2 ft. | 5 yd. 1 ft. |
| <hr/>
3 rd. 1 ft. 6 in. | <hr/>
6 rd. 1 yd. |

26. From 8 rd. 1 ft. take 2 rd. 2 ft.
27. Find the difference between 3 rd. 1 yd. 1 ft. and 16 rd.
28. Multiply 5 rd. 4 yd. 2 ft. by 4.
29. Multiply 11 rd. 2 ft. by 10.
30. Divide 30 rd. 5 yd. 2 ft. by 8.
31. Divide 34 rd. 2 yd. by 9.

REVIEW OF COMMERCIAL DISCOUNT.**505. Oral Exercises.**

When the list price is \$1, what is the net price after the deduction of each of the following discounts?

1. 30 and 20%.

The net price after a deduction of 30% is 70% of \$1, or 70¢. Deducting 20% of 70¢ leaves 80% of 70¢, or 56¢.

4. 50 and 10%.

5. 40 and 20%.

6. 10 and 5%.

7. 20 and 20%.

2. 40 and 10%.

The net price is 60% of 90% of \$1, or 54% of \$1.

8. 33 $\frac{1}{3}$ and 10%.

9. 20 and 15%.

3. 25 and 40%.

10. 30 and 15%.

506. What single discount is equal to each of the following double discounts?

11. 30 and 30%.

The net price is 70% of 70% of list price, or 49% of list price. The discount is, therefore, 100% - 49%, or 51%.

15. 40 and 30%.

16. 30 and 10%.

17. 40 and 5%.

12. 20 and 25%.

18. 50 and 20%.

13. 25 and 20%.

19. 40 and 15%.

14. 15 and 30%.

20. 50 and 15%.

Find the single discount equal to each of the following:

21. 50 and 20 and 10%.

22. 40 and 25 and 20%.

23. 10 and 10 and 10%.

24. 30 and 20 and 10%.

507. Written Exercises.

Which is the better discount for the buyer?

1. 30 and 20%, or 40 and 10%.

30 and 20% off = 70% of 80% net, or 56% net. 40 and 10% off = 60% of 90% net, or 54% net. The latter is the better for the buyer.

2. 50 and 10%, or 40 and 20%.
3. 20 and 20%, or 30 and 10%.
4. 20 and 15%, or 30 and 5%.
5. 30 and 15%, or 25 and 20%.
6. 30 and 30%, or 50 and 10%.
7. 40 and 30%, or 20 and 50%.
8. 40 and 5%, or 30 and 15%.
9. 20 and 50%, or 60 and 10%.
10. 40 and 15%, or 30 and 25%.

REVIEW OF INTEREST.**508. Six Per Cent Method.**

Interest is the product of the *principal* by the *rate* expressed as hundredths by the *time* in years and fraction. The usual method is to perform the operations in the above order. When the rate is 6%, some prefer to first multiply the rate by the time, and to use this as a multiplier of the principal.

In finding the product of the rate by the time, advantage is taken of the fact that 6 is a factor of 12 and 30. Six per cent a year is $\frac{1}{2}$ per cent a month and $\frac{1}{6}$ per cent a day.

When the rate is a different per cent, the interest is first obtained at 6 per cent by this method, and from this result the interest is calculated for the given rate.

509. Find the interest on \$2874.35 at $3\frac{1}{4}\%$ for 3 yr. 7 mo. 19 da.

\$2874.35	.218 $\frac{1}{4}$	.18
	.47905+	
22.99480		
28.7435		
574.870		
6) \$627.08735		
\$104.5145+		
	3 $\frac{1}{4}$	
313.5435		
78.3859		
\$391.9294		
\$391.93	Ans.	

Multiplying the principal by .218 $\frac{1}{4}$ gives the interest at 6% for 3 yr. 7 mo. 19 da.

Dividing this product by 6 gives the interest at 1%. Multiplying the quotient by 8 $\frac{1}{4}$ gives the interest at $3\frac{1}{4}\%$.

To find the interest at 6 per cent, multiply the principal by 6 times the number of years and $\frac{1}{2}$ the number of months as hundredths, together with $\frac{1}{3}$ the number of days as thousandths.

510. Written Exercises.

Find the interest at 6% on:

1. \$1428 for 1 yr. 4 mo. 6 da.
2. \$372.50 for 2 yr. 6 mo. 24 da.
3. \$1875 for 3 yr. 9 mo. 18 da.
4. \$240 for 4 yr. 7 mo. 15 da.
5. \$92.75 for 5 yr. 4 mo. 8 da.
6. \$817.80 for 10 mo. 19 da.

The interest at 6% plus $\frac{1}{2}$ of itself gives the interest at 7%.

The interest at 6% minus $\frac{1}{2}$ of itself gives the interest at 5%.

The interest at 6% plus $\frac{1}{3}$ of itself gives the interest at 8%.

The interest at 6% minus $\frac{1}{3}$ of itself gives the interest at 4%.

The interest at 6% plus $\frac{1}{4}$ of itself gives the interest at 7 $\frac{1}{4}\%$.

The interest at 6% minus $\frac{1}{4}$ of itself gives the interest at 4 $\frac{1}{4}\%$.

511. Written Exercises.

Find the amount :

1. \$1875.25 for 3 yr. 5 mo. 15 da., at $4\frac{1}{2}\%$.
2. \$487.50 for 1 yr. 10 mo. 25 da., at 6%.
3. \$1206.84 for 2 yr. 1 mo. 16 da., at 5%.
4. \$595.00 for 7 yr. 7 mo. 7 da., at 7%.
5. \$763.25 for 8 mo. 11 da., at 4%.
6. \$685.70 for 19 mo. 5 da., at $5\frac{1}{2}\%$.
7. \$1563.00 for 3 mo. 20 da., at 5%.
8. \$998.45 for 87 da., at $4\frac{1}{4}\%$.
9. \$2575.50 for 149 da., at 3%.
10. \$693.27 for 214 da., at $2\frac{1}{2}\%$.

Find the principal, rate, or time :

11. Principal, \$240; interest, \$32.04; time, 2 yr. 11 mo. 18 da. Rate?
12. Rate, 6%; amount, \$717.40; time, 3 yr. 3 mo. 4 da. Principal?
13. Principal, \$360; rate, 3%; interest, \$48.87. Time?
14. Principal, \$288; rate, $2\frac{1}{2}\%$; amount, \$307.22. Time?
15. Rate, 6%; interest, \$13.10; time, 4 mo. 11 da. Principal?
16. Principal, \$270; amount, \$273.27; time, 3 mo. 19 da. Rate?
17. Rate, $4\frac{1}{2}\%$; interest, \$25.11; principal, \$360. Time?
18. Interest, \$50.22; time, 3 yr. 1 mo. 6 da.; rate, $4\frac{1}{2}\%$. Amount?

REVIEW OF BANK DISCOUNT.

512. Written Exercises.

Find face of note, term of discount, rate, discount, or proceeds:

By the *term* is meant the number of days the note has to run, including grace, if any.

1. Face, \$600; discount, \$6.30; rate, 6%. Term?
2. Term, 33 days; proceeds, \$397.80; rate, 6%. Face?
3. Term, 90 days; face, \$300; rate, 6%. Proceeds?
4. Term, 21 days; face, \$600; discount, \$2.45. Rate?
5. Term, 4 months; face, \$200; rate, 6%. Discount?
6. Term, 132 days; proceeds, \$2689.50; rate, 6%. Face?
7. Face, \$150; proceeds, \$147.75; rate, 6%. Term?
8. Face, \$1650; discount, \$4.95; rate, 6%. Term?
9. Term, 69 days; proceeds, \$469.30; rate, 6%. Face?

EXACT INTEREST.

Exact interest is used by the United States Government in its calculations. 365 days are taken to the year.

513. Written Exercises.

1. Find the exact interest of \$280 from April 14 to Sept. 6 at 4%.

Time, 145 days. *Ans.* $\$280 \times \frac{1}{160} \times \frac{145}{365}$.

2. Find the exact interest on \$76.65 from March 4 to Dec. 15 at 6 per cent.
3. On \$384 at $7\frac{3}{10}$ per cent for 75 days.
4. On \$438 at 5% from Jan. 1 to March 15.
5. On \$109.50 at $4\frac{1}{2}\%$ for 87 days.
6. On \$847.60 at 5% from April 29 to Sept. 20.
7. \$584 at $3\frac{3}{4}\%$ from May 16 to Dec. 1.

Unless "exact" or "accurate" interest is specified, use 360 days to the year.

MISCELLANEOUS.**514. Oral Review Problems.**

1. A has 96 sheep; B has 28 sheep more than A. How many sheep have both?
2. There are 56 pupils in one class, 48 in a second class, and 52 in a third class. How many pupils are there in the three classes?
3. March 29 is what day of the year 1904?
4. How far is a man from his starting-point, if he travels due east 150 miles, due west 23 miles, due east again 48 miles?
5. A body falls 16 feet in the first second, three times as far in the second second, five times as far in the third second. How far does it fall in three seconds?
6. The base of a right-angled triangle is 12 feet, the perpendicular is 16 feet. What is the hypotenuse?
7. At \$35 per month, what will be the rent of a house for 16 months?
8. A field containing 169 square rods is 13 rods long. What is the perimeter?
9. 25 packages of sugar weigh together $87\frac{1}{2}$ pounds. How many pounds are there in each?
10. At 45 miles per hour, how many hours, minutes, and seconds will it take a train to go 230 miles?
11. How many years have elapsed since the invention of gunpowder, 1356?
12. What profit is made on an article bought for \$175, less 12%, and sold for \$200?
13. How many square rods in a field 71 rods long, 81 rods wide?

14. Assuming a kilo to be $2\frac{1}{2}$ pounds, how many kilos will be equal to 143 pounds?

15. A degree of longitude in latitude 45° is about 70% of the length of a degree on the equator. Calling the latter length 69 miles, how long is a degree of longitude in latitude 45° ?

16. At \$44 per acre, how much land can be bought for \$968?

17. A number of marbles divided among 29 boys gives each 16 marbles, and leaves a remainder of 26. How many marbles are there?

18. What is the monthly salary of a clerk who receives \$1500 per year?

19. How many revolutions in a mile, 5280 feet, are made by a locomotive wheel 16 feet in circumference?

20. What is the perimeter of a lot 49 feet wide, 87 feet long?

21. How many bricks 8 inches by 4 inches by 2 inches would make a cubic foot?

22. 13 is one factor of 1001. Find the other two prime factors.

23. What are the three equal factors of 343?

24. What is the square root of 1225?

25. At $4\frac{1}{2}$ miles per hour, how long will it take a man to walk $37\frac{1}{2}$ miles?

26. What will be the cost of 9 dozen hats at \$1.33 $\frac{1}{2}$ each?

27. Paid 92¢ for coffee, 48¢ for butter, and 18¢ for lard. How much was my bill?

28. I had \$150. Spent \$23 for a suit of clothes and \$48 for tools. How much was left?

29. What is the area of a field 36 yards by 31 yards?

30. 600 hours equal how many days ?
31. What is the cost of a cow if I pay \$630 for 15 ?
32. How many ounces in $29\frac{1}{2}$ pounds ?
33. $109\frac{1}{4}$ pounds of sugar are divided among 4 people. What is the share of each ?
34. At $1\frac{9}{10}\text{¢}$ per pound, how many pounds of iron can I get for \$5.70 ?
35. What is the cost of 51 tons iron at \$17 per ton ?
36. What will be the average age of 9 boys, each 12 years old, and 6 boys, each 10 years old ?
37. At 42 miles per hour, how long will it take a train to go 882 miles ?
38. At 25¢ per hour, what will a man earn in 18 days of 10 hours ?
39. What will be the net price of an article whose catalogue price is \$20.00, the discount being 90 and 10% ?
40. A man had \$181 in bank. What will be his balance after taking out \$47 and \$33 ?
41. How many feet in 14 rods ?
42. 77 yards are how many rods ?
43. How many square yards are there in a floor $10\frac{1}{2}$ yards long and $6\frac{1}{2}$ yards wide ?
44. What is the cost of 372 eggs at 15¢ per dozen ?
45. A man owns 3 farms containing 65 acres, 86 acres, and 98 acres, respectively. How many acres does he own ?
46. What is the area of a piece of glass measuring $8\frac{1}{2}$ by $6\frac{1}{4}$ inches ?
47. What is the value in U. S. money of 50 marks at $23\frac{8}{10}$ cents ?
48. How many francs will a calf cost, if 18 are worth 630 francs ?

49. A man spends \$1740 per year. What is the average amount spent per month?
50. What would 51 pounds of butter cost at $33\frac{1}{2}$ ¢ a pound?
51. Mrs. Allen bought 7 chairs at \$4 apiece, 2 tables at \$9 apiece, and a carpet for \$33. She paid two \$50 bills. How much change was due her?
52. In what time will any sum of money double itself, at 6%?
53. Find the sum of the prime numbers as far as 12.
54. Interest of \$1234, for 30 days, at 6%?
55. Interest of \$1234, for 6 months, at 4%?
56. Oil is worth $37\frac{1}{2}$ ¢ a pint. How many pints can be bought for \$6?
57. Sold oranges for $\frac{1}{2}$ ¢ apiece, gaining 50%. How much did they cost apiece?
58. What will be the cost of 1 pk. 1 qt. 1 pt. of nuts, at 10¢ per quart?
59. What is the value of an acre of land, at 10¢ per square foot?
60. 3 desks are bought at \$10 each, and sold for \$45. Find the rate of gain.
61. A wheelman sells his old bicycle for \$25, and loses $16\frac{2}{3}\%$. How much did it cost him?
62. How much does an agent get for buying 5 bales of goods at \$400 each, if he receives 3% for his services?
63. 10% of 200 is $\frac{1}{2}$ of what number?
64. How old, December 1, 1903, was a boy born November 25, 1889?
65. A man has \$1000 in bank. What will remain after he has taken out \$478?
66. How many hours in the month of January?

67. In how many years, months, and days will \$100 amount to \$111, at 5%, simple interest?
68. What will 5 tons of granulated sugar cost, at $6\frac{1}{2}$ ¢ per pound?
69. What is the interest of \$50, for 3 yr. 7 mo. 12 da., at 6%?
70. A farmer makes 675 gallons of cider. He has but 12 barrels, each of 45 gallons' capacity, to store it in. How many more such barrels does he need?
71. What will be the cost of 36 yards of cloth, at \$2.75 per yard?
72. Add 3794 and 2975.
73. What is the bank discount on a sixty-days note for \$400, at 6%?
74. Change $\frac{9}{11}$ to a decimal of three places.
75. How much wood in three piles containing, respectively, $\frac{1}{2}$ of a cord, $\frac{1}{3}$ of a cord, and $\frac{1}{4}$ of a cord?
76. What is the percentage of gain in case of railroad stock bought for \$80 per share, and sold for \$90 per share?
77. A dealer sold flour at a profit of 50¢ a barrel, and gained 10%. What was the cost?
78. At 10¢ a quart, what are 3 bu. 1 pk. 5 qt. of chestnuts worth?
79. How many yards in 288 inches?
80. What decimal of a number is $\frac{2}{3}$ per cent of it?
81. If a broker buys for me 5 shares of railroad stock whose par value is \$100, what is his brokerage at $\frac{1}{2}\%$?
82. If I sell 10 shares of railroad stock for \$1090, and gain 9% on the cost, what was the cost?
83. What is the interest of \$660, for 3 months, at 4%?

84. What per cent does a merchant lose by selling goods at $\frac{1}{2}$ of their cost?
85. What principal at 6% simple interest will gain \$36 in 1 year and 6 months?
86. What per cent is gained on goods sold at double the cost?
87. What is 8% of 50 bushels?
88. \$3000 is $11\frac{1}{2}\%$ of my property. How much am I worth?
89. What is the interest on \$700, for 15 days, at 6%?
90. Bank discount on a 65-days note for \$1000, discounted at date?
91. At what rate will \$2 gain \$20 in 5 years?
92. A capitalist wishes to realize 5% on money invested in stock. What must be the annual dividend on stock costing 300, in order to produce this rate?
93. What will be the taxes on property assessed at \$25,000, the rate being \$16 per \$1000?
94. Find the compound interest on \$1000, for two years, at five per cent, interest compounded annually.
95. What will be the net cost of an article marked \$8, on which a discount of 50, 25, and 10% is allowed?
96. Find the "list" price of an article sold for \$10 after a discount of 50 and 50 per cent had been deducted.
97. Paid 90¢ for an article. The discount is 25 and 25 per cent. What is the list price?
98. One boy can do a certain piece of work in 2 hours, a second boy requires 3 hours, a third needs 6 hours. How long will it take the three working together?
99. Sold a cow for \$60, losing 25%. What was the loss?
100. Sold a cow for \$60, gaining 25%. What was the gain?

101. Sold two horses at \$240 apiece. On one I gained 20%, on the other I lost 20%. Did I gain or lose on both, and how much?

102. What is the interest of \$1500, for 60 days, at 6%?

103. How many years will it take \$20 to gain \$20 at 5 per cent simple interest?

104. John has \$60, James has \$80. James has what per cent more money than John? John has what per cent less money than James?

105. $\frac{2}{3}$ is what per cent of $\frac{1}{2}$? $\frac{1}{2}$ is what per cent of $\frac{2}{3}$?

106. Two men working together can finish a piece of work in 8 days; one can do it in 12 days. How long would the other take to do the work?

107. How many yards of cloth at \$3.75 per yard can be bought for \$90?

108. A puts \$600 into business; B, \$400; the profits are \$500. What is the share of each?

109. Two boys hire a camera for 26 weeks, paying \$5.20. How much should be paid by the boy that uses it 12 weeks?

110. New Orleans is 90° west of Greenwich. When it is 2 P.M. at the latter place, what is the time at New Orleans?

111. Find the discount, at 6%, on a note for \$300, that has 48 days to run.

112. What will be the cost of 84 yards of cloth at 49¢ a yard?

113. Two men hire a pasture for \$84. One puts in twice as many head of cattle as the other. What should each pay?

114. A base-ball club won 17 games, and lost 13 games. What per cent of its games did it win?

115. What per cent of 4 is 64?

116. $2\frac{2}{3}$ is what per cent of $3\frac{1}{2}$?

117. How many acres in a rectangular farm 1 mile long, $\frac{7}{8}$ mile wide?

118. What per cent of the "list" price is paid by a buyer who receives a discount of 20 and 10 per cent?

119. A tank is filled by two pipes, one of which can fill it in 6 hours, and the other in 8. How long will it take both together to fill the tank?

120. Find the interest on \$80, for 72 days, at 6%.

121. A man sold a wagon for \$420, which was 16% less than it cost. How much did he lose?

122. A kilo is 2.2046 lb. How many pounds in 1000 kilos?

515. Written Review Problems.

1. What number subtracted 88 times from 80.005 will leave .013 as a remainder?

2. At what price must an article that cost \$30 be marked so that after deducting 40% from the marked price, 30% profit may be realized?

3. Write a ninety-days promissory note for which you should get \$240 at the bank, discount being 6%.

4. If a horse dealer buys a span of horses at 10 per cent less than their value, and sells them at 10 per cent more than their value, what per cent does he make?

5. If a boy buys peaches at the rate of 5 for 2 cents, and sells them at the rate of 4 for 3 cents, how many must he buy and sell to gain \$4.20?

6. What is the difference between the compound interest on \$5000, for 3 years, at 5%, and on \$10,000, for $1\frac{1}{2}$ years, at the same rate?

7. A can do a piece of work in 27 days, and B in 15 days; A works at it alone for 12 days, B then works alone for 5 days, then C finishes the work in 4 days. In what time could C have done the work by himself?

8. A room is 15 feet long, 10 feet broad, and 9 feet 9 inches high. Find the cost of painting the walls and the ceiling, at 1s. 9d. a square yard.

9. What is the value of a pile of wood 40 feet long, 4 feet wide, and 5 feet high, at \$5.30 a cord?

10. By buying a cargo of coal at \$6 per ton, and selling it at \$8 a ton, I gained \$198. How much did I pay for it?

11. Make out a receipted bill for the following: 325 yards of silk at \$2.25 per yard; 296 yards of lace at \$1.50 per yard; 480 yards of ribbon at \$0.50 per yard; 45 dozen pairs of gloves at \$15 per dozen pairs.

12. My dividend is $8\frac{3}{4}$, quotient $9\frac{1}{4}$. What is the divisor?

13. I gave away $\frac{1}{3}$ and $\frac{2}{3}$ of $4\frac{1}{2}$ bushels of chestnuts. What % was left?

14. The perimeter of a square field is 16 rods. What is the field worth, at $8\frac{1}{2}$ ¢ a square foot?

15. A broker's bill for cotton at $47\frac{1}{2}$ ¢ per pound and his commission for buying at $2\frac{1}{2}\%$ was \$1998.75. How many bales of 400 pounds each did he buy, and what was his commission?

16. I sold 80 yards of broadcloth for \$240, thereby losing 20% on the cost. For what should I have sold it per yard to have gained 15% on the cost?

17. A man bought 60 casks, of 65 gallons each, for \$1542; 80 gallons leaked out. For what must he sell the remainder per gallon to gain $12\frac{1}{2}\%$ on the cost?

18. Each of two men sold his horse for \$180. One made 20%, the other lost 20% on the cost. Cost of each horse?

19. A man agrees to dig a cellar 30 feet long, 24 feet wide, and 6 feet deep. What % of the work is to be done when he has removed 144 cubic yards?

Chapter Six.

20. A man bought 672 yards of cloth at \$ 1.25 a yard. He sold it immediately for \$ 2.25 a yard, receiving in payment a 60-days note for the amount, which he had discounted at a bank at 7%. How much money did he make?

21. What will it cost to fill in a street 55 feet wide, 600 feet long, and $5\frac{1}{2}$ feet below grade, at 40¢ a cubic yard?

22. The quotient arising from the division of 6985.473 by a certain number is 51, and the remainder is 68.853. What is the divisor?

23. What is the value of the following?

$$\frac{3\frac{3}{5} + 4\frac{4}{5} - 6\frac{5}{8}}{2\frac{1}{4} + 1\frac{3}{4} - 3\frac{1}{2}} \div \frac{\frac{8}{5} \times \frac{7}{16} \times \frac{2}{3}}{\frac{9}{4} \times \frac{3}{4} \times \frac{2}{3}}$$

24. In going 1 mi. 94 rd. 2 yd. 1 ft., a carriage wheel makes 526 revolutions. What is the circumference of the wheel?

25. On a note dated Oct. 16, 1903, for \$ 2650, with interest at 6 per cent, the following payments were made: Jan. 28, 1904, \$ 575; May 22, 1904, \$ 25; and Aug. 4, 1904, \$ 948. What was due Nov. 25, 1904?

26. A grocer pays 18¢ per pound for coffee and roasts it, the coffee losing 10 per cent of its weight in the process. What must he charge per pound for the roasted coffee in order to make a profit of 20 per cent, allowing 4 per cent for bad debts?

Note. — 96% of the price he receives per pound must be 20% more than the rate of 18¢ for $\frac{9}{10}$ lb.

27. A merchant imported from Bremen 32 pieces of linen of 32 yards each, on which he paid for the duties, at 24 per cent, \$ 122.16, and other charges to the amount of \$ 40.96. What was the invoice value per yard, and the cost per yard after duties and charges were paid?

28. A garrison of 1200 men is provisioned for 100 days. At the end of 30 days, 600 men are withdrawn, and at the end of 60 days, 900 men are added. How long will the provisions last?

29. What will be the result, if $\frac{1}{2}$ of $\frac{3}{4}$ of $3\frac{1}{2}$ be multiplied by $\frac{1}{2}$ of itself, and the product be divided by $\frac{1}{2}$?

30. A collector of internal revenue deposited in the treasury \$762,742.50, retaining $2\frac{1}{2}$ per cent of the amount collected. What amount did he collect?

31. What is the duty on 25 tons 2 cwt. 3 qr. of iron at \$8 per ton? (1 ton = 2240 lb.)

32. An importer sold a part of a cargo of tea at 30 cents a pound and made a profit of 20 per cent. What per cent did he make on the remainder of the cargo, which he sold at 40 cents a pound?

33. Divide \$4.14 among Thomas, Richard, and Henry in such a way that Henry shall receive 3 cents for every 5 cents that Thomas gets, and Richard shall receive 2 cents for every 5 cents that Henry gets.

34. Reduce 272 liquid quarts to dry quarts.

35. A pipe discharging 3 gallons 1 pint a minute fills a tub in 4 minutes 20 seconds. Another pipe discharges 83 quarts a minute. If both pipes discharge together into the tub, how long will they take to fill it?

36. William Wilson sold goods to the amount of \$1000. One-half of his sales showed a profit of 25 per cent on the cost, and the remaining half a loss of $16\frac{2}{3}$ per cent on the cost. Required the total cost of the goods.

37. If I sell $\frac{3}{4}$ of my farm for $\frac{4}{5}$ of what the farm cost me, what is my gain per cent?

38. Which is the higher rate of freight on wheat, \$.16 per hundred or \$.10 per bushel (60 lb.), and what per cent?

39. Write in words:
 (a) .267; (b) 200.067; (c) $\frac{260}{7000}$; (d) 200, $\frac{810}{7000}$.
40. If 40 per cent of the selling price of an article is profit, what is the per cent of gain on the cost?
41. What number added to $4\frac{1}{2}$ times itself will equal $60\frac{1}{2}$?
42. Divide $\frac{1}{3}$ by .00003 $\frac{1}{2}$.
43. Reduce to lowest terms (a) $\frac{1781}{10000}$; (b) $\frac{457}{400}$.
44. If 4 men eat 64 pounds of bread in 2 weeks, how many pounds will 16 men eat in 7 weeks at the same rate?
45. Divide .75 of $17\frac{5}{8}$ by $\frac{1}{4}$ of .035.
46. Find the cost of 3846 pounds of hay at \$15 per ton.
47. Find the cost of plastering the walls and the ceiling of a hall 72 feet long, 50 feet wide, and 22 feet high, at 18 $\frac{1}{4}$ cents a square yard, allowing 972 square feet for openings and baseboards.
48. A certain quantity of paper will make 4000 copies of an octavo book (8 pages to the sheet). How many copies of a 12mo book (12 pages to the sheet) will the same paper make?
49. Find the diagonal of a square park containing 20 acres.
50. BANGOR, MAINE, June 24, 1904.
 On demand, I promise to pay Joseph I. Totten, or order, Two Thousand Five Hundred Fifteen Dollars, with interest, value received.
- \$2515 $\frac{00}{100}$. CHARLES HETTESHEIMER.
 \$1541.01 was paid Jan. 1, 1905. Find the amount due Aug. 15, 1905.
51. How much does it cost annually to insure the "Celtic" for \$1,525,000, if 2 $\frac{1}{4}\%$ is paid for the insurance?
52. \$150 is paid an agent for purchasing 1200 barrels of flour on a commission of 2 $\frac{1}{2}\%$. How much was paid per barrel for the flour?

53. An agent received \$2562.50 for purchasing land at \$62.50 per acre, and his commission of $2\frac{1}{2}\%$. How many acres did he buy?

54. Reduce the fraction $\frac{8\frac{1}{2} \times \frac{7}{18}}{\frac{1}{18} \text{ of } 3\frac{1}{2} \div \frac{1}{4} \text{ of } 7\frac{7}{11}}$.

55. Divide $\frac{7}{8}$ by 2.5, to the quotient add the divisor, and from that sum subtract the dividend. Give the fractional part of the answer in a decimal.

56. If the interest on \$300 for 1 yr. 8 mo. is \$36, find what would be the interest on \$212.50 for 3 yr. 4 mo. 24 da. at the same rate.

57. Reduce .0468 T. to a compound number.

58. Find the prime factors of 20,930.

59. A man paid \$999 for the rent of a house from June 29, 1903, to May 5, 1905. What was the rent per year?

60. What per cent of 3 lb. 7 oz. is 7 lb. 9 oz.?

61. At 50 cents per running yard, what will be the cost of fencing a square field containing 10 acres?

62. At the rate of 20 problems an hour for A, and 15 in 55 minutes for B, in what time can both together solve 100 problems?

63. Find the entire surface of a cube whose edge measures 15 inches.

64. A dealer buys books at \$1.50 each, less $33\frac{1}{3}\%$ and 10 per cent. At what price per copy must he sell them to gain $43\frac{1}{3}\%$ per cent?

65. Abraham Lincoln died at the age of 56 yr. 2 mo. 3 da., after serving as President 4 yr. 1 mo. 11 da. Give the date of his birth, the date of his inauguration being March 4, 1861.

66. A dealer buys 150 barrels of flour. He sells one-third of it at \$4.50 per barrel, losing 10 per cent. The remainder he sells at a profit of 6 per cent. What is his net gain or loss?

67. Sixty per cent of $66\frac{2}{3}$ per cent of a number equals 810. What is the number?

68. A ladder 40 feet long is so placed in a street, that without being moved at the foot, it will reach a window on one side 33 feet, and on the other side 21 feet from the ground. What is the breadth of the street?

69. Four men hired a coach for \$13, to convey them to their respective homes, which were at distances from the place of starting as follows: A's 16 miles, B's 24 miles, C's 28 miles, and D's 36 miles. What ought each to pay?

70. What is a pile of wood 8 feet long, 7 feet wide, and 5 feet high worth, at \$4.50 per cord?

71. When bank stock sells at a discount of $7\frac{1}{2}$ per cent, what amount of stock, at par value, will \$3700 purchase?

72. The pound sterling is worth \$4.8665. How much U. S. coin would it require to pay a debt of £780 18s. 11d.?

73. A merchant imported 120 tons of English iron, costing $1\frac{1}{2}$ pence per pound, on which he paid a duty of 20 per cent. The freight was 5 shillings sterling per ton. What was the total cost in U. S. currency? (1 ton = 2240 pounds. £1 = \$4.8665.)

74. How many rods of fence are required to enclose a square lot whose area is 5184 square feet?

75. Property worth \$6000 is insured for $\frac{3}{4}$ of its value, at $\frac{3}{4}$ of one per cent. What will be the loss, including premium, in case of total destruction by fire?

76. How many acres of land, in the form of a square, may be enclosed by 160 rods of fence?

77. Find the square root of .441 correct to two decimal places.
78. Reduce 17 lb. 10 oz. Avoirdupois weight to pounds, ounces, pennyweights, and grains, troy weight. (1 pound Avoirdupois = 7000 Troy grains.)
79. Reduce $\frac{151}{275}$ to its lowest terms.
80. Find the solid contents of a cube, the area of one face of which is 256 square feet.
81. A car contains 21,643 pounds of wheat. Find the value of the load at 92¢ per bushel of 60 pounds.
82. Find the area of a triangle whose base is 22 ft. 8 in., and altitude 19 ft. 9 in.
83. The list price of a certain stove is \$ 38, and the retail dealer is allowed commercial discounts of 20 per cent, 5 per cent, and 3 per cent. What price does he pay for the stove?
84. If a ton of coal lasts a family 21 days, what will be the cost of coal used by it from Oct. 17, 1904, to April 25, 1905, exclusive of either day named, at \$ 4.50 per ton?
85. Find the cost of a pile of 4-foot wood, 27 feet long and 6 feet high, at \$ 5.50 per cord.
86. How many rods of fence will be required to enclose a field in the form of a right-angled triangle, whose area is $13\frac{1}{2}$ acres and whose base measures 48 rods?
87. What is the balance of a bill of \$ 64.50, after two discounts have been made; the first of 20% on the \$ 64.50, the other of 5% on what then remained?
88. There was shipped to Liverpool from New York in one week \$ 6,870,205 in specie. What amount of English currency could be bought with it? (£ 1 = \$ 4.8665.)
89. What is the freight on 9860 pounds iron at \$ 1.75 per ton?

90. What is the value of 10 lb. 7 oz. 16 pwt. of gold at \$.75 a pennyweight?
91. The dividend is 6171, the quotient 17, the remainder
102. What is the divisor?
92. Divide the L. C. M. of 132 and 156 by their G. C. D.
93. The product of three numbers is .0728; one of them is 1.3, another .07. Find the third.
94. If 5 men can make 38 rd. 5 yd. of fence in a day, how much can they build in 30 days?
95. The distance from New York to New Haven being 73 mi. 8 rd., at what rate does a train run per hour to cover the distance in 2 hr. 10 min.?
96. Reduce 4 da. 4 hr. 48 min. to the decimal of a week.
97. After 4 per cent of a flock of sheep had been killed by dogs, and 68 had been sold to a butcher, four-sevenths of the original flock were left. Required the number of sheep in the flock at first.
98. Six men bought a ship worth \$ 45,268, for which A paid $\frac{1}{4}$ of the whole, B $\frac{1}{3}$, and the others paid the remainder equally. How much did each of the latter pay?
99. A man agrees to dig a cellar 30 feet long, 24 feet wide, and 6 feet deep. What per cent of the work has he done when he has removed 16 cubic yards?
100. How many boards 16 feet long, and 4 inches wide, are required to floor a room 48 feet long, and 32 feet wide?
101. How much walking does a man save by crossing diagonally a field 28 rods long, and 21 rods wide, instead of going along the end and the side?
102. In order to have an annual income of \$ 2500, what sum must be invested at 5%?
103. At \$ 2 a rod, what is the difference in the cost of fencing a lot of land 20 rods square, and another lot containing the same area which is 40 rods long?

104. If a man owning 45% of a steamboat sells $\frac{1}{4}$ of his share for \$5860, what is the value of the whole boat?
105. A farmer having 6 bu. 8 qt. of cranberries lost by decay 7 pk. 7 qt. What % had he left?
106. Sold tea for 114% of its cost, and made a profit of 7¢ a pound. Find selling price.
107. In $\frac{2}{3}$ of an acre of land how many building lots, each 60 feet by 121 feet?
108. I bought a store for a certain sum, and after paying a tax of $2\frac{1}{2}\%$ on the cost and $\frac{1}{2}\%$ more for insurance I sold it for \$7828, which exactly covered the cost, tax, and insurance. What was the cost?
109. Parker P. Simmons, of Vermont, sent to Nostrand Bros. of Boston, to be sold on commission, the following goods: 25 tons of hay, 2 tons of butter, 1500 pounds of maple sugar, 75 gallons maple syrup. Nostrand Bros. sell the hay at \$18 a ton, the butter at 20¢ a pound, the sugar at 7¢ a pound, the syrup at 90¢ a gallon.
Nostrand Bros. charge 2% commission. How much do they send to Parker P. Simmons?
110. How much will a granite block weigh which is 7 feet long, 2 ft. 6 in. wide, 3 ft. 4 in. high? (12 cubic feet of granite weigh a ton.)
111. A coal dealer bought 350 tons of coal, weighing 2240 pounds each, at \$3.50 a ton. He sold the coal at \$4.25 a ton, each ton weighing 2000 pounds. What was his profit?
112. Mrs. Burns buys 40 yards of carpet $\frac{3}{4}$ of a yard wide. She uses 10% of it for a rug, and the remainder to carpet a floor. How many square yards does she use for the floor?
113. Mr. Burns sold his carriage for \$224, which was $\frac{4}{5}$ of its cost. What per cent would he have gained if he had sold it for \$210?

Chapter Six.

114. What is the difference between four thousand nine and seven hundred eighty-six ten-thousandths, and four hundred thousand nine and seven hundred eighty-six millionths?
115. Discover a fraction which, multiplied by $\frac{1}{6}$, equals $\frac{1}{3}$.
116. What $\%$ of $\frac{1}{2}$ of $\frac{5}{4}$ of $\frac{2}{3}$ is $\frac{1}{2}$?
117. How many inches in $\frac{1}{16}$ of a mile?
118. Bought a horse for \$90, and sold him for \$95. What per cent of gain? Bought another horse for \$95, and sold him for \$90. What per cent was lost?
119. Bought land at \$62.50 per acre, and sold it again at \$75 per acre, thereby making \$8468.75. How many acres were bought?
120. Two ships sail from the same port; one goes due north 128 miles, and the other due east 72 miles. How far are the ships from each other? Illustrate.
121. B and C, trading together, find their stock to be worth \$3500, of which C owns \$2100. They have gained 40% on their first capital. What did each put in?
122. A general wished to remove 80,000 pounds of provisions from a fortress in 9 days. It was found that in 6 days 18 men had carried away but 18 tons. How many men would be required to carry away the remainder in 3 days?
123. A schoolroom is 40 feet long, 30 feet wide, and 14 feet high. Find the difference between the length of a diagonal drawn on the floor and one drawn from the floor to the ceiling.
124. Find the solid contents and the surface of a sphere 12 inches in diameter.
125. The number of copies in the first edition of the "Lady of the Lake" was 2050, and was to the number in the second edition as 41 to 69. Find the number in the second edition.

126. Find the proceeds of the following note:

\$1050 $\frac{90}{100}$.

CHICAGO, Feb. 13, 1905.

Six months after date I promise to pay to the order of John G. Agar One Thousand Fifty Dollars, with interest at 6 per cent.

HENRY R. M. COOK.

Discounted at 8 per cent, May 13.

127. A can do $\frac{1}{4}$ of a piece of work in 4 days, and B can do $\frac{1}{4}$ of it in 5 days. In what time can they do the whole work together?

128. A square is inscribed in a circle whose diameter is 84 inches. Find the area of the four segments of the circle outside of the square.

129. Find the difference between the volume of a cylinder whose diameter and height are 12 inches, and the volume of a sphere whose diameter is the same.

130. A certain cistern can be filled by one pipe in 10 hours, by another in 6 hours, and can be emptied by a third in 5 hours. In how many hours can it be filled if all three pipes are opened at once?

131. Two men start from two towns 105 miles apart and walk toward each other. They meet at the end of 15 hours. The first has travelled 3 miles per hour. At what rate has the second travelled?

132. If a cipher is added at the right of the decimal, what effect has this on the value of the decimal? Explain the reason.

133. What is the easiest method of dividing a decimal by 10?

134. If the numerator of a common fraction is divided by 3, what is the effect upon the value of the fraction?

135. If the denominator is divided by 3, what is the effect upon the value of the fraction?

136. What is the effect on the value of a decimal of moving the decimal point two places to the right? Explain the reason.

137. What is the exact interest on \$400, from March 1 to December 17, at 5 per cent? (365 days to the year.)

138. In what time will a principal amount to $2\frac{1}{2}$ times itself, at 10 per cent?

139. A and B in partnership have together a capital of \$7500, and gain \$1200. A's share of the gain is \$250. What is B's share of the gain? What is B's share of the capital?

140. The circumference of a circle is 15.708 feet. What is the radius of it?

141. The radius of a circle is 42. What is the circumference of it?

142. Find the entire surface of a cylinder 10 inches long, and 8 inches in diameter. Find the number of cubic inches in the same cylinder.

143. Explain the reason for multiplying the second and third terms together and dividing by the first term in solving an example in simple proportion.

144. Divide thirty-two hundred-millionths by sixty-four ten-thousandths.

145. A, B, and C gained by speculation \$11,480, of which A's share was twice as much as C's, and B's five times as much as C's. How much did each gain?

146. A pole was broken 52 feet from the bottom, and it fell so that the top struck 39 feet from the foot, while the other end of the broken portion remained attached. Required the length of the pole.

147. Sold a horse so that $\frac{1}{4}$ of the gain equalled $\frac{1}{5}$ of the cost. What was the gain per cent?

148. In what time will the interest on £57 1s. 8d. amount to £2 11s. 4½d. at 7½ per cent per annum?

CHAPTER VII.

ALGEBRAIC EQUATIONS.

ONE UNKNOWN QUANTITY.

516. A number increased by 12 equals 16.

This may be written, $x + 12 = 16$.

The second way is shorter. Here x stands for the number.

517. Preliminary Exercises.

Tell what x may stand for, and write in a short way each of the following:

1. A number increased by 5 equals 7.
2. 6 is added to a number. The sum is 9.
3. 4 subtracted from a number leaves 1.
4. 12 diminished by a number has 8 for a remainder.
5. A number is subtracted from 10. The remainder is 3.
6. 10 is subtracted from a number. The remainder is 3.
7. The number of years of John's age added to 3 years equals 15 years.
8. In two years Mary will be 11 years old.
9. 5 years ago Thomas was 8 years old.
10. If William should add 5 marbles to the number he now has, he would have 15 marbles.
11. If Kate spends 10 cents, she will have 15 cents left.
12. When paying for a top, Henry received 7 cents change from 10 cents.

13. A ball and a bat together cost 40 cents. The bat cost 15 cents.

14. A watch cost Mr. Smith \$60. He bought the case and the works separately. The works cost \$20.

15. The weight of a loaded wagon is 3200 pounds. The load weighs 2000 pounds.

518. Sight Exercises.

If	$x + 7 = 9,$
then	$x = 2,$
because	$2 + 7 = 9.$

Find the value of x :

- | | |
|---------------------------|----------------------------|
| 1. $x + 6 = 9.$ | 9. $x + 5 = 15.$ |
| 2. $x - 4 = 1.$ | 10. $x + 5 = 8.$ |
| 3. $x + 5 = 7.$ | 11. $x - 7 = 10.$ |
| 4. $10 - x = 3.$ | 12. $x - 10 = 15.$ |
| 5. $x - 10 = 3.$ | 13. $x + 20 = 60.$ |
| 6. $12 - x = 8.$ | 14. $x + 15 = 40.$ |
| 7. $x + 2 = 11.$ | 15. $x + 2000 = 3200.$ |
| 8. $x + \frac{1}{2} = 1.$ | 16. $x + \frac{1}{2} = 1.$ |

COEFFICIENTS.

519.

(1) $3x$ means 3 times x .

(2) $2\frac{1}{2}a$ means $2\frac{1}{2}$ times a .

(3) ax means a times x .

In (1), 3 is the coefficient of x .

In (2), $2\frac{1}{2}$ is the coefficient of a .

In (3), a is the coefficient of x .

Notice that the coefficient and its letter are written side by side. Is there any sign between them? What sign is understood? What is a coefficient?

520. Written Exercises.

Write in a short way, and tell what x stands for.

1. 8 times a number = 64.
2. A butcher receives 63 cents for a piece of meat at 9 cents a pound.
3. $2\frac{1}{2}$ yards of muslin cost 25 cents.
4. A lady paid 40 cents for 3 spools of black silk and 2 spools of white silk at the same price per spool.
5. A man worked by the day 10 days on my barn and 8 days on my house. For all this work he received \$36.
6. A man spent $\frac{1}{4}$ of his week's wages for a pair of boots. The boots cost him \$3.
7. 11 times a number less 2 times the number is 27.
8. John's money is in pennies and nickels. He has the same number of each. He has 42 cents.

521. Sight Exercises.

If $10x - 7x = 18$,
 then $3x = 18$,
 and $x = 6$.

PROOF: $60 - 42 = 18$.

Give value of x at sight:

- | | |
|---------------------------|----------------------------|
| 1. $8x = 64$. | 8. $11x - 2x = 27$. |
| 2. $9x = 63$. | 9. $3x - 2x + 5x = 54$. |
| 3. $3x + 2x = 40$. | 10. $10x + 8x - 4x = 42$. |
| 4. $2\frac{1}{2}x = 25$. | 11. $2x + 4x = 52 - 16$. |
| 5. $\frac{1}{4}x = 3$. | 12. $3x + 4x = 30 - 9$. |
| 6. $10x + 8x = 36$. | 13. $12x - 5x = 25 + 10$. |
| 7. $4x - 3x = 72$. | 14. $6x + 6x = 16 + 8$. |

522. Oral Exercises.

If $a = 2$, and if $b = 3$, and if $c = 7$.

- | | |
|--------------------|-----------------|
| 1. $a + b = ?$ | 8. $ac - b = ?$ |
| 2. $b - a = ?$ | 9. $abc = ?$ |
| 3. $a + b + c = ?$ | 10. $? = 9.$ |
| 4. $c - a + b = ?$ | 11. $? = 21.$ |
| 5. $c - a - b = ?$ | 12. $? = 23.$ |
| 6. $ab = ?$ | 13. $? = 19.$ |
| 7. $ab + c = ?$ | 14. $? = 4.$ |

523. Written Problems.

1. A horse and a wagon cost together \$600. What is the price of each, if the wagon costs twice as much as the horse?

Let

x = cost of horse;

then

$2x$ = cost of wagon.

Cost of both

$$= 2x + x = 600.$$

$$3x = 600.$$

$$x = 200.$$

$$2x = 400.$$

Ans. Cost of horse, \$200; of wagon, \$400.

2. Divide 100 into two parts, one of which shall be four times as large as the other.

Let

x = one part;

then

$4x$ = the other.

$$x + 4x = 100.$$

3. \$18,000 is divided among three children, the second of whom receives twice as much as the first, and the third of whom receives six times as much as the first. Required the share of each.

$$x, 2x, 6x.$$

4. In a class of 54 pupils, there are twice as many boys as girls. How many are there of each?
5. The sum of two numbers is 78. One is five times as large as the other. What are the numbers?
6. 156 is equal to seven times a number added to five times the same number. Find the number.
7. The difference between three times a certain number and nine times the same number is 66. What is the number?
8. \$27,000 is divided among three children, the second of whom receives twice as much as the first, and the third of whom receives three times as much as the second. What is the share of each?
9. The sum of two numbers is 72, and the greater is 5 times the other. What are the numbers?
10. John, Henry, and James have 54 marbles. Henry has twice as many as John, and James has as many as the other two. How many has each?
11. The sum of the ages of mother and daughter is 42 years. What is the age of each, if the mother's age is six times that of her daughter?
12. A man paid \$96 for an equal number of hats and coats, paying \$2 apiece for the former and \$10 apiece for the latter. How many of each did he buy?

Let x = number of each,
then $2x$ = cost of hats,
 $10x$ = cost of coats.

13. Divide 41 into four parts, the first being twice the second, the second three times the third, and the third four times the fourth. (Let x = the fourth.)

14. The sum of three numbers is 180. The first is double the second, and the third is three times as large as the sum of the other two. What are the numbers?

15. Mr. Smith paid 81 cents for sugar and flour, the same quantity of each. For the sugar he gave 5¢ per pound, and for the flour 4¢ per pound. How many pounds of each did he buy?

16. The length of a rectangular field is 24 rods, its breadth is x rods, its area is 456 square rods. Find the value of x .

17. It takes 340 feet of fence to enclose a square lot. What are the dimensions of the lot?

18. Mrs. B. divides \$120 between her son and her daughter. She gives the latter twice as much as she gives the former. What is the share of each?

19. The earnings of a man and his son during January amounted to \$175, both having worked the same number of days. The father's wages were \$4 per day, and the son's wages were \$3 per day. How many days did they work?

20. The sum of \$240 is divided among four children, two boys and two girls. Find the share of each, if each girl's share is double that of each boy.

21. A man worked twice as many days as his son. Their combined earnings amounted to \$165. Find the number of days each worked, if the father earned \$4 per day and the son three-fourths as much per day.

22. A boy's bank contains 78¢ in dimes, nickels, and cents. There are twice as many nickels as there are dimes, and three times as many cents as there are nickels. How many are there of each?

23. I paid 75¢ more for a roll of 15-cent ribbon than I did for a roll of 12-cent ribbon of the same length. How many yards did each roll contain?

24. A rectangular field whose length is four times its breadth requires 250 rods of fence to enclose it. What are the dimensions of the field? (Make diagram.)

25. A girl paid 60 cents for a speller and a reader, the cost of the former being one-third that of the latter. Find the cost of each.

26. The sum of two numbers is 72, and the smaller is one-fifth of the other. What are the numbers?

Let x = smaller.

27. Mary, Susan, and Jane have 54 hickory nuts. Susan has one-half as many as Mary, and Jane has as many as the other two. How many has each?

Let x = number Susan has.

EQUATIONS.

524. An expression like $3x + 16 = 28$ is an *equation*.

$3x + 16$ is the first member of the equation.

28 is the second member of the equation.

What is the part of the equation to the left of the equality sign called? What is the second member of an equation? What sign is between the two members? What does this sign show about the value of the two members? What is an equation?

525. Written Exercises.

Suppose $a = 2$ and $b = 3$.

Complete the equations:

1. $ab + ? = 7$.

6. $ab + b = 5 + ?a$.

2. $a + b - ? = 4$.

7. $17 - ab = 5a + ?$

3. $?a + b = 11$.

8. $17 - ab - ? = 5a$.

4. $ab = a + b + ?$

9. $12 + ab = 2b + ?a$.

5. $ab = 12 - ?b$.

10. $12 + ab - ?a = 2b$.

CLEARING OF FRACTIONS.

526. Oral Exercises.

1. One-fifth of a number is 4. What is the number?
2. $\frac{1}{2}$ of a number is 8. What is $\frac{3}{4}$ of the number?
3. $\frac{1}{4}$ of a number is 12. What is the number?
4. $\frac{1}{4}$ of a number is 10. What is $\frac{3}{4}$ of the number?
5. If $\frac{2}{3}$ of a number is 30, what is the number?
6. One-half a number added to $\frac{1}{4}$ of the same number equals what fraction of the number?
7. One-half a number added to $\frac{1}{4}$ of the same number equals 30. What is the number?
8. One-third of a number + one-sixth of the number = what fraction of the number?
9. One-third of a number added to $\frac{1}{4}$ of the number = what fraction of the number?
10. $\frac{1}{3}x + \frac{1}{4}x$ = what fraction of x ? $\frac{x}{3} + \frac{x}{4} = ?$

527. When $x = 32$, find the value of three-fourths of x ; i.e., $\frac{3x}{4}$.

When $\frac{3x}{4}$ ($3x$ divided by 4) = 24, what is the value of $3x$? Of x ?

Find the value of y , when $\frac{y}{3} = 12$. Of $2y$, when $\frac{2y}{3} = 24$.

Given the equation $\frac{4z}{5} = 20$; by what whole number can we multiply the first member to get rid of the fraction? If we multiply one member of an equation by any number, what must we do to the second member in order to preserve the equality?

If equals are multiplied by equals the products are equal.

528. Sight Exercises.Give values of x , y , z , etc.:

- | | | |
|---------------------------------------|--------------------------------------|--|
| 1. $\frac{x}{5} = 4.$ | 5. $\frac{w}{2} + \frac{w}{4} = 12.$ | 9. $\frac{v}{5} + \frac{v}{5} = 8.$ |
| 2. $\frac{2y}{5} = 8.$ | 6. $\frac{x}{2} + \frac{x}{3} = 5.$ | 10. $\frac{w}{3} + \frac{2w}{3} = 32.$ |
| 3. $\frac{z}{4} = 7.$ | 7. $\frac{y}{3} + \frac{y}{6} = 10.$ | 11. $\frac{x}{4} + \frac{x}{5} = 9.$ |
| 4. $\frac{3v}{4} = 21.$ | 8. $\frac{z}{3} + \frac{z}{4} = 7.$ | 12. $\frac{x}{2} + \frac{2x}{5} = 9.$ |
| 13. $\frac{x}{2} - \frac{x}{4} = 2.$ | | 15. $\frac{x}{2} - \frac{x}{5} = 6.$ |
| 14. $\frac{x}{3} - \frac{x}{12} = 3.$ | | 16. $\frac{x}{2} - \frac{x}{7} = 5.$ |

529. Written Exercises.Find the value of the unknown quantity (x).

1. $\frac{x}{2} + \frac{x}{3} + \frac{x}{4} = 26.$

Multiplying by 12, we have $6x + 4x + 3x = 312.$

2. $x + \frac{x}{2} + \frac{x}{3} = 44.$

Multiply by 6. $6x + 3x + 2x = 264.$

To clear an equation of fractions multiply each term of both members by the least common denominator of the fractions.

3. $\frac{x}{2} + \frac{x}{3} = 35.$

6. $\frac{8}{5}x + \frac{5}{4}x = 92.$

7. $\frac{2x}{3} + \frac{3x}{4} = 102.$

4. $\frac{x}{3} + \frac{x}{4} = 49.$

8. $2\frac{1}{4}x = 115.$

5. $\frac{x}{2} + \frac{2x}{3} = 28.$

9. $\frac{4x}{5} - \frac{2x}{3} = 48.$

10. $x - \frac{x}{40} = 156.$

19. $\frac{75x}{100} - \frac{33x}{50} = 81.$

11. $3\frac{1}{2}x = 116.$

20. $\frac{8x}{3} - \frac{2x}{5} = 136.$

12. $\frac{3x}{2} = 27.$

21. $\frac{x}{2} + \frac{x}{3} + \frac{x}{4} = 39.$

13. $1\frac{1}{2}x = 27.$

22. $x - \frac{x}{2} - \frac{x}{3} = 37.$

14. $\frac{11x}{4} = 22.$

23. $\frac{4x}{5} - \frac{2x}{9} + \frac{3x}{4} = 239.$

15. $2\frac{3}{4}x = 44.$

24. $\frac{5x}{9} + \frac{2x}{3} - \frac{x}{2} = 52.$

16. $2x + \frac{3x}{4} = 33.$

25. $x - \frac{3x}{4} = 80.$

17. $3\frac{1}{2}x - 2\frac{3}{4}x = 45.$

26. $x + 2x + \frac{3x}{7} = 24.$

18. $x + \frac{x}{5} = 24.$

530. Written Problems.

1. Divide 100 into two parts, one of which shall be $1\frac{1}{2}$ times the other.

2. After losing $\frac{1}{4}$ of his money, a man has \$714. How many dollars had he at first?

$$\left(x - \frac{x}{8} = 714 \right).$$

3. A horse was sold for \$240, the seller thereby gaining one-third of what he originally paid for it. How much did he pay for it?

$$\left(x + \frac{x}{3} \right).$$

4. One-half of a number added to one-fourth of the same number equals $66\frac{1}{4}$. What is the number?

5. The difference between $\frac{4}{5}$ of a number and $\frac{2}{3}$ of the same number is 15. Find the number.

6. One number is $\frac{4}{5}$ of another. Their sum is 55. What are the numbers?

7. Find a fraction equivalent to $\frac{7}{8}$, the sum of its numerator and its denominator being 60.

(Let $7x$ = numerator and $8x$ = denominator.)

8. Find a fraction equivalent to $\frac{5}{6}$, the difference between its numerator and its denominator being 24.

9. The sum of two numbers is 480, and the quotient obtained by dividing the greater by the less is 7. What are the numbers?

10. Find two numbers whose difference is 522 and whose quotient is 30.

11. A boy buys apples at 2¢, pears at 3¢, and oranges at 4¢, the same number of each. How many of each does he buy, if he pays 81¢ for all?

12. A girl bought 70 cents' worth of peaches and plums. She paid 3¢ each for the peaches and 2¢ each for the plums, buying four times as many of the former as of the latter. How many of each did she buy?

13. \$1500 is divided among three persons, the second of whom receives three times as much as the first, and the third three and one-half times as much as the first. Find the share of each.

14. A farmer paid for a cow three-sevenths as much as he paid for a horse. How much did he pay for each, if the latter cost \$80 more than the former?

15. Three times a man's money increased by two-thirds of his money is equal to \$1100. How much money has he?

16. After giving away $\frac{2}{5}$ of his marbles and losing $\frac{1}{4}$ of them, Joseph has 24 left. How many had he at first?

17. Bought a coat, a hat, and an umbrella for \$15, paying for the hat $1\frac{1}{2}$ times as much as for the umbrella, and for the coat $3\frac{1}{2}$ times as much as for the hat. Find the price of each.

18. A merchant purchased two pieces of cloth for \$240, paying for one piece twice as much per yard as for the other. The former contains 36 yards and the latter 48 yards. How much does he pay per yard for each?

19. A farmer sold 4 times as many cows as horses, receiving for all \$840, at the rate of \$40 for a cow and \$120 for a horse. How many of each did he sell?

20. The weight of a team with a loaded wagon is 5500 pounds. The wagon weighs $\frac{1}{2}$ as much as the load. The team weighs twice as much as the wagon. How many pounds does the load weigh?

531. Oral Exercises.

Give values of x , y , z , etc.:

$$1. \quad x + 15 = 21.$$

$$7. \quad 3y + 6 = 15.$$

$$2. \quad 2y + 15 = 21.$$

$$8. \quad 7y - 13 = 15.$$

$$3. \quad z - 7 = 21.$$

$$9. \quad 9y + 13 = 58.$$

$$4. \quad 4w - 7 = 21.$$

$$10. \quad 3y - 10 = 56.$$

$$5. \quad \frac{v}{2} + 3 = 8.$$

$$11. \quad \frac{3v}{4} + 1 = 7.$$

$$6. \quad \frac{x}{2} - 3 = 12.$$

$$12. \quad \frac{4w}{5} - 1 = 11.$$

532. If $x + 15 = 21$, $x = 21 -$ what?

When $x - 7 = 21$, $x = 21 +$ what?

If in the equation $2x + 15 = 21$, we take away 15 from the first member, what must we do to the second member to preserve the equality?

If equals are subtracted from equals, the remainders are equal.

By *transposing* we mean bringing the unknown quantities (x , y , z , etc.) to one side of the equation and the known quantities to the other.

Note. — In bringing a quantity from one side of the equation to the other, the *sign* of the quantity is changed.

533. Written Exercises.

Find values of the unknown quantities.

NOTE. — Clear of fractions when necessary ; then transpose.

1. $x + 37 = 56.$
2. $4x - 5 = 83.$
3. $3x - 43 = 98.$
4. $7x + 13 = 111.$
5. $x + 3x = 25 + 11.$
6. $5x = x + 40.$
7. $3x - 20 = x - 8.$
8. $12 - 3x = 45 - 4x.$
9. $3x - 6 = 48 + x.$
10. $3x + 6 = 9 - 2x + 12.$
11. $2x - 2 - 16 = x + 10.$
12. $\frac{x}{3} - 8 = 24.$
13. $\frac{x}{6} + 4 - 7 = 21.$
14. $\frac{x}{2} + \frac{x}{3} = 10 + 5.$
15. $7x - 5x = 20 + x + 4$
16. $6x - 14 = 16 + x$
17. $2x - 11 + 6x - 60 = 5x + 25.$
18. $\frac{x}{2} + \frac{x}{3} - 5 = 10.$
19. $2x - 6 = 16 + \frac{x}{2} - \frac{x}{3}.$
20. $2x + \frac{3x}{5} - \frac{x}{2} = \frac{3x}{4} + 27.$

534. Written Problems.

1. The sum of three numbers is 51. The second is 5 less than the first, and the third is 10 less than the first. What are the numbers ?

Let

x = first number,

$x - 5$ = second number,

$x - 10$ = third number ;

$$x + x - 5 + x - 10 = 51.$$

Transposing, $x + x + x = 51 + 5 + 10,$

$$3x = 66,$$

$$x = 22, \text{ first number,}$$

$$x - 5 = 17, \text{ second number,}$$

$$x - 10 = 12, \text{ third number.}$$

2. Add 45 to four times a number, and you will have seven times that number. What is the number?

$$(7x = 45 + 4x.)$$

3. Nine times a number less 27 equals six times the number. Find the number.

4. Two boys have together 48 marbles. One has 18 more than the other. How many has each?

$$(x, x + 18.)$$

5. The length of a rectangular lot is 75 feet more than the breadth. The distance around it is 250 feet. What are its dimensions?

6. A piece of land containing 86 acres is to be divided into two fields, one of which shall be 8 acres larger than the other. How many acres in each field?

7. At a certain election 2436 votes were cast for two candidates, the successful one receiving 318 more votes than his opponent. How many votes did each receive?

8. A man, being asked his age, replied that if he were half as old again and 7 years more he would be 100. What was his age?

9. The sum of two numbers is 96, and their difference is 72. Find the numbers.

$$(\text{Let } x = \text{less}, x + 72 = \text{greater.})$$

10. After paying $\frac{1}{3}$ and $\frac{1}{4}$ of my debts, I still owe \$45. How much did I owe originally?

$$x - \frac{x}{3} - \frac{x}{4} = 45.$$

11. Divide 45 into two parts, one of which shall be 6 less than twice the other.

12. William has \$5 more than John, and three times William's money added to five times John's would be \$103. How many dollars has each?

13. I bought 3 cows and 4 horses for \$635, paying \$80 apiece less for the cows than for the horses. How many dollars apiece did I pay for each?

14. Mary has a dollar in dimes and five-cent pieces. She has 11 more of the latter than of the former. Find the number of pieces of each denomination.

15. Divide 100 into two parts whose difference shall be 48.

16. In a class of 54 pupils, the girls outnumber the boys by 12. How many are there of each?

17. \$18,000 is divided among three persons, the second of whom receives \$2400 more than the first, and the third of whom receives \$2400 more than the second. Find the share of each.

18. The greater of two numbers is 11 more than 3 times the less. Their difference is 33. What are the numbers?

19. A boy spent a dollar for postal cards, 2-cent stamps, and 5-cent stamps. He bought 15 more 2-cent stamps than 5-cent stamps, and 15 more postal cards than 2-cent stamps. How many of each did he buy?

Let x = number of 5-cent stamps,
then $x + 15$ = number of 2-cent stamps,
 $x + 30$ = number of postal cards.

$5x$ = value of 5-cent stamps,
 $2x + 30$ = value of 2-cent stamps,
 $x + 30$ = value of postal cards.

$$5x + 2x + 30 + x + 30 = 100$$

20. A farmer has 88 head of stock — horses, cows, and sheep. He has 17 more cows than horses, and the number of sheep is 22 greater than that of the cows and horses together. How many are there of each?

ADDITION OF ALGEBRAIC QUANTITIES.

535. Oral Exercises.

Add:

1. 2 fours	2. 6 hundredths	3. \$4	4. 3¢	5. 7 x
3 fours	8 hundredths	\$5	5¢	4 x
4 fours	10 hundredths	\$7	8¢	2 x
5 fours	12 hundredths	\$3	9¢	5 x
? fours	? hundredths	\$?	?¢	? x

When no coefficient is expressed, 1 is understood. Thus,
 $abc = 1 abc$.

Where no sign is expressed, + is understood.

6. - 2 a	7. + 3 x	8. - 5 xy	9. 9 abc	10. - 24 xyz
- 4 a	+ 4 x	- 4 xy	15 abc	- 5 xyz
- 6 a	+ 5 x	- xy	6 abc	- xyz
- 7 a	+ 10 x	- 2 xy	abc	- 15 xyz
- 19 a	+ ? x	- ? xy	? abc	- ? xyz

NEGATIVE QUANTITIES.

536. Suppose three men as follows:

The first man has \$5 and owes nothing.

The second man has \$5 and owes \$5.

The third man has nothing and owes \$5.

The first man is worth \$5.

The second man is worth nothing.

The third man is worth 5 less than nothing. So we may say he is worth - \$5.

537. Quantities like -\$5, -17, and -2 a are called negative quantities.

What sign precedes a negative quantity?

Quantities with a plus sign expressed or understood are called positive quantities.

538. Oral Exercises.

1. A man bought a horse for \$100. He sold it for \$110.
What was his gain?

2. A man bought a horse for \$200. He sold it for \$175.
What was his gain? *Ans. — \$25.*

3. A man earned \$60 during November. He spent \$45.
How much did he save?

4. A man earned \$60 during December. He spent \$70.
How much did he save?

5. A man went north from a starting point 10 miles.
He then went south 8 miles. How far north of his starting
point was he then?

6. A man went north from a starting point 10 miles.
He then went south 14 miles. How far north of his start-
ing point was he then?

7. What is meant by a gain of — \$5?

8. What is meant by — 5 miles east?

9. What is the meaning of this statement? A woman
is — 3 inches taller than her husband.

10. John is 3 years older than Mary. Mary is how
many years older than John?

ADDITION OF POSITIVE AND NEGATIVE QUANTITIES.**539. Preliminary Exercises.**

1. On Monday an agent makes \$6 above his expenses;
on Tuesday, — \$3; on Wednesday, \$4; on Thursday, \$8;
on Friday, — \$2; on Saturday, \$7.

2. Another agent's profits for the days of the week are
— \$3, \$2, — \$2, \$4, — \$1, — \$2.

We may put down the above statements thus:

\$ 6	\$ -3
- 3	2
4	- 2
8	4
- 2	- 1
7	- 2
<u>\$ 20</u>	<u>\$ - 2</u>

In the first example we add all the positive quantities, \$ 6 + \$ 4 + \$ 8 + \$ 7 = \$ 25. Then we add all the negative quantities, - \$ 3 - \$ 2 = - \$ 5. Adding \$ 25 and - \$ 5 the result is \$ 20.

In the second example we add all the positive quantities, and get \$ 6. The sum of the negative quantities is - \$ 8. Adding \$ 6 and - \$ 8 the result is - \$ 2.

Can you give the rule for addition where the quantities have different signs? Which sign does the sum take?

540. Written Exercises.

Add:

- | | | | | |
|---------|-------|----------|-----------|------------|
| 1. - 2a | 2. 7x | 3. - 5xy | 4. - 9abc | 5. - 24xyz |
| - 4a | - 4x | - 4xy | 15abc | 5xyz |
| - 6a | - 2x | xy | 6abc | xyz |
| 7a | 5x | 2xy | - abc | 15xyz |

6. $3x + 14$, $- 7x + 9$, $- 23$, $4x - 5$, $- 2x$, and $3x + 11$.

Write like quantities in the same column.
Find the sum of the positive terms, also
the sum of the negative terms; subtract
the less from the greater, and prefix the
sign of the greater.

$$\begin{array}{r} 3x + 14 \\ - 7x + 9 \\ \hline - 23 \\ 4x - 5 \\ - 2x \\ \hline 3x + 11 \end{array}$$

7. $4a + 3x$, $- 2a$, $- 7x - 3a$, $- 5x$, $- 9a + x$.
 8. $- 3b + c$, $4a + 6b$, $5b - 9c$, $- 3a$, $- 2a - 3b + 4c$.
 9. $\frac{1}{2}x - 8$, $- x + 4$, $-\frac{1}{2}x - 3$, $7x + 16$, $- 5x - 10$.
 10. $4x + 23$, $- 8x + 2\frac{1}{2}$, $-\frac{3}{2}x + 11$, $- x + 5$, $9x - 3$.

SUBTRACTION OF ALGEBRAIC QUANTITIES.

541. Preliminary Exercises.

1. A man sold a horse for \$ 100 at a gain of \$ 25. Find the cost. (Cost = selling price — gain.)

$$\begin{array}{rcl} \$100 & = & \text{selling price} \\ \text{subtract } & 25 & = \text{gain} \\ \hline \text{remainder } & \$75 & = \text{cost} \end{array} \quad \begin{array}{rcl} \$100 \\ \text{or add } & -25 \\ \hline & \$75 \end{array}$$

2. A man sold a horse for \$ 100 at a gain of — \$ 25. Find the cost.

$$\begin{array}{rcl} \$100 & = & \text{selling price} \\ \text{subtract } & -25 & = \text{gain} \\ \hline \text{remainder } & \$125 & = \text{cost} \end{array} \quad \begin{array}{rcl} \$100 \\ \text{or add } & +25 \\ \hline & \$125 \end{array}$$

In the first of the above examples, subtracting + \$ 25 is the same as adding — \$ 25.

In the second of the above examples, subtracting — \$ 25 is the same as adding + \$ 25.

We changed the first example from subtraction to addition by changing the sign of the subtrahend from + to —.

We changed the second example from subtraction to addition by changing the sign of the subtrahend from — to +.

To subtract in algebra, change the sign of the subtrahend and proceed as in addition.

3. Add 7 and — 3.
4. From 7 subtract — 3.
5. From — 7 subtract 3.
6. Add — 7 and 3.
7. Add — 7 and — 3.
8. From — 3 subtract — 7.
9. Subtracting — 7 is the same as adding what?
10. Is a positive quantity increased or decreased by subtracting a negative quantity?

NOTE. — When you become familiar with the process of subtraction it will not be necessary to *write* the subtrahend with a changed sign. You can *conceive* the sign changed and add.

542. Sight Exercises.

1. What is the difference between $+52^\circ$ and $+33^\circ$?

2. Between $+90^\circ$ and -10° ?

Show by a diagram.

3. A has \$600, B owes \$400. What are they worth together? $(+\$600) + (-\$400) = ?$

4. How much better off is A than B?

$$(+\$600) - (-\$400) = ?$$

543. Written Exercises.

1. From $8a$ take $2a$.

$$\begin{array}{r} 8a \\ - 2a \\ \hline Ans. \quad 6a \end{array}$$

2. From $2a$ take $8a$.

$$\begin{array}{r} 2a \\ - 8a \\ \hline Ans. \quad - 6a \end{array}$$

3. From $-8a$ take $2a$.

$$\begin{array}{r} -8a \\ - 2a \\ \hline Ans. \quad -10a \end{array}$$

4. From $8a$ take $-2a$.

$$\begin{array}{r} 8a \\ + 2a \\ \hline Ans. \quad 10a \end{array}$$

5. From $-8a$ take $-2a$.

6. From $-2a$ take $8a$.

7. From $-2a$ take $-8a$.

8. From $2a$ take $-8a$.

$$\begin{array}{r} 3x+14 \\ - x-10 \\ \hline \end{array}$$

10. From $5x-8$ take $-3x-9$.

11. From $x-28$ take $5x-37$.

12. From $7x+16$ take $9x-4$.

13. From $6x$ take $2x-5$.

14. From $8x$ take $9x+3$.

15. From $3x+2a-5$ take $x-a-9$.

16. From $7y-2z+b$ take $-8y+6b-z$.

17. From $c-d+e$ take $c+d-f$.

REMOVING PARENTHESES.

544. Written Exercises.

1. From $6x + 15y$ take $4x + 10y$.

We may write the above in a shorter way, thus :

$$6x + 15y - (4x + 10y).$$

The minus sign before the parenthesis shows that the quantity within the parenthesis is to be subtracted. What sign is before $10y$? What sign is understood within the parenthesis before $4x$? In subtraction, what is done with the signs of the subtrahend? If the whole expression is written without using the parenthesis, what must be done with the signs of the quantities within the parenthesis?

$a - (b - c)$ may be written $a - b + c$. Why?

$a + (b - c)$ may be written $a + b - c$. Why?

When removing a parenthesis preceded by a minus sign, change the signs of all quantities within the parenthesis.

545. Written Exercises.

Write the following without parentheses :

- | | |
|---------------------------------------|------------------------------------|
| 1. $57 + (33 - 16) = 74.$ | 4. $(17 - 8) - (16 - 14) = 7.$ |
| 2. $92 - (63 + 25) = 4.$ | 5. $75 + 4 \times (15 - 10) = 95.$ |
| 3. $(43 - 10) + (24 - 5) = 52.$ | 6. $75 - 4 \times (15 - 10) = 55$ |
| 7. $4x + 5y + (2x - 6y) = 6x - y.$ | |
| 8. $4x + 5y - (2x + 6y) = 2x - y.$ | |
| 9. $4x - 5y - (x - 6y) = 3x + y.$ | |
| 10. $4x - 5y - (-x + 6y) = 5x - 11y.$ | |
| 11. $4x + 5y - (-2x - 6y) = ?.$ | |
| 12. $-4x - 5y + (2x - 6y) = ?.$ | |

546. Solve the following equations. Prove the correctness of your answers.

$$1. \quad 6(2x - 5) = 5x + 12.$$

NOTE. $6(2x - 5)$ means 6 times $(2x - 5)$, or $12x - 30$.

$$2. \quad 7(x + 2) = 3x + 50. \quad 4. \quad 3(16 - x) = 4(13 - x).$$

$$3. \quad 5(3 + x) + 16 = 61. \quad 5. \quad 15(x - 3) = 2(189 - 16x)$$

$$6. \quad 38 - (11 - 9x) = 10x.$$

Removing the parenthesis, we have

$$38 - 11 + 9x = 10x.$$

$$\text{Transposing,} \quad 9x - 10x = -38 + 11,$$

$$\text{or,} \quad -x = -27.$$

Bringing $-x$ to the right side of the equation, and -27 to the left side, we have

$$(+27) = (+x).$$

In practice, however, when the result is such as the above, $-x = -27$, the signs of both members are changed, and the result becomes

$$x = 27.$$

$$7. \quad 2(x - 1) - 2(2x - 19) = 3(x - 3).$$

$$8. \quad 6(2x - 5) - 5x = 12.$$

$$9. \quad 5x - 6(2x - 5) = -12.$$

$$10. \quad \frac{11 - 3x}{2} + 5x = 19.$$

$$547. \quad \frac{18 - 6}{2} - \frac{24 - 4}{5} = 2.$$

Clear of fractions by multiplying both members of the equation by 10, and observe which sign must be changed to preserve the equality.

When $x = 6$, the above may be written

$$\frac{3x - 6}{2} - \frac{4x - 4}{5} = 2.$$

Clearing of fractions, $15x - 30 - (8x - 8) = 20$.

Removing the parenthesis,

$$15x - 30 - 8x + 8 = 20.$$

Transposing,

$$15x - 8x = 20 + 30 - 8,$$

or,

$$7x = 42,$$

$$x = 6.$$

Note. — The horizontal line between the numerator and the denominator of the foregoing fractions has the effect of a parenthesis, the *entire* quantity above the line being divided by the number below.

Hence when an equation is cleared of fractions, what must be done with the signs of the terms obtained from a fraction with a minus sign?

$$\frac{18 - 6}{2} = (18 - 6) \div 2, \quad \frac{24 - 4}{5} = \frac{1}{5} \text{ of } (24 - 4).$$

$$\frac{8x - 6}{2} = \frac{1}{2} \text{ of } (8x - 6), \quad \frac{4x - 4}{5} = (4x - 4) \div 5.$$

548. Solve:

$$11. \quad \frac{x-1}{2} + \frac{x-2}{3} = 8.$$

$$12. \quad \frac{x-1}{2} - \frac{x-2}{3} = 2.$$

$$13. \quad \frac{x-1}{2} - \frac{x-2}{3} - \frac{x-3}{4} + 2 = 0.$$

$$14. \quad \frac{2x-5}{2} + \frac{x-7}{4} = \frac{5x-3}{6}.$$

$$15. \quad \frac{7x-8}{9} - (x+2) = \frac{4x+5}{6} - \frac{x+2}{3}.$$

$$16. \quad \frac{40-5x}{3} = \frac{52+9x}{7}.$$

$$17. \quad 9\frac{1}{4} - \left(\frac{5}{4}x - \frac{x}{2} \right) = \frac{5}{8}x + 3\frac{3}{4}x.$$

$$18. \quad 2x = 3 + 2\frac{1}{4}x - (5 + \frac{2}{5}x) + 2\frac{1}{4}.$$

$$19. \quad \frac{3}{2}x + 9 = 2x + (\frac{3}{5}x - \frac{1}{2}x).$$

$$20. \quad \frac{x}{4} + \frac{x}{5} + \frac{x}{6} + \frac{x}{8} + 31 = x.$$

$$21. \frac{1}{4}x - 120 = \frac{x}{6} + 10.$$

$$22. x - 20 = \left(\frac{x}{7} + 15\right)4.$$

$$23. x + \frac{x}{3} + \frac{x}{4} = 19.$$

$$24. 9(8x + 1) - 4 = 4(9x + 5) + 3.$$

$$25. 2x + 3 = \frac{5x - 6}{2}.$$

549. Written Problems.

1. A certain number is multiplied by $3\frac{1}{2}$; 7 is subtracted from the product; the remainder is divided by 16, giving a quotient of 3. What is the number?

2. Three-eighths of what number is 60 less than the number itself?

3. Four persons are of the same age. If the first were $\frac{1}{2}$ of his age older, the second $\frac{1}{4}$ of his age older, the third $\frac{1}{6}$ of his age older, and the fourth $\frac{1}{8}$ of his age older, the sum of their ages would be 99 years. What is the age of each?

4. A man spends $\frac{1}{2}$ of his earnings on board and lodging, $\frac{1}{8}$ on clothing and repairs, and $\frac{1}{5}$ on sundries. At the end of the year he has \$280 left. What are his yearly earnings?

$$x = \frac{x}{2} + \frac{x}{8} + \frac{x}{5} + 280.$$

5. A boy gave $\frac{1}{3}$ of his marbles to one companion, and $\frac{1}{4}$ of them to another. He then bought $\frac{1}{2}$ as many as he originally had, and had 4 marbles more than he had at first. How many did he have at first?

6. A father's age and a son's age added together amount to 138 years. Twelve years ago the father was twice as old as the son. How old is each now?

Let x = son's age 12 years ago. $2x$ = father's age then.

7. John has 80 cents, and William has 60 cents. How many cents should William give John so that the latter might have $2\frac{1}{2}$ times as much money as the former?

After William gives John x cents, the former has $(60 - x)$ cents, and the latter has $(80 + x)$ cents.

8. In how many years will a man, now 25, be double the age of his 11-year-old brother?

Let x = number of years. $25 + x$ and $11 + x$ = ages after x years.

9. A man has a cask of 60 gallons' capacity. He draws off one-fourth of its contents, and then fills it. If it takes 24 gallons to fill it, how many gallons did the cask originally contain?

10. A number is divided by 3, and 40 is subtracted from the quotient, leaving a remainder of 104. What is the number?

11. The difference between two numbers is 430. When the greater is divided by the less, the quotient is 4, and the remainder is 76. What are the numbers?

$$\text{Let } x = \text{less. } \frac{\text{greater}}{\text{less}} = 4 + \frac{76}{\text{less}}$$

12. A person pays \$103 with 29 \$2 and \$5 bills. How many are there of each denomination?

13. A father is 30 years older than his daughter. In 4 years, his age will be four times her age. What are their present ages?

x and $x + 30$ = present ages. $x + 4$ and $x + 34$ = ages 4 years later.

14. The product of two numbers is 180. If the smaller number be increased by 3, the product of the two numbers will be 225. What are the numbers?

$$\text{smaller} = x; \frac{180}{x} = \text{greater.}$$

15. A man's wages are \$1 per day more than his son's. For 33 days' work, the father receives \$12 more than the son earns in 40 days. Find the wages of each.

TWO UNKNOWN QUANTITIES.

550. Preliminary Problems.

1. I paid a dollar for two 25¢ balls and five bats. How much did I pay apiece for the latter?
2. When three times one number is added to five times another, the sum is 84. If the second number is 12, what is the first number?
3. A girl paid 75¢ for $\frac{1}{2}$ pound of tea and $2\frac{1}{2}$ pounds of coffee. The coffee cost 20¢ per pound. What was the price of the tea per pound?
4. A man sold pigs at \$5 each and lambs at \$8 each, receiving \$42. He sold 4 lambs. How many pigs did he sell?
5. Four times a father's age added to twice his daughter's age amounts to 180 years. The girl is 10 years old. What is the father's age?
6. Eight peaches and seven pears cost 44¢. The peaches cost 2¢ each. What is the cost of a pear?
7. Two pieces of cloth and eleven pieces of silk contain 152 yards. There are 10 yards in each piece of cloth. How many yards in each piece of silk?
8. Two-thirds of a yard of linen and three-fourths of a yard of lace cost 40¢. The price of the lace is 32¢ a yard. Find the price of the linen.
9. Three and one-half times one number added to four and one-third times a second number equals 60. The second number is 9. What is the first number?

551. Written Exercises.

Find the value of the unknown quantity:

1. $8x + 7y = 44$. When $x = 2$, find the value of y .
2. $3y + 5z = 34$. Find the value of z ; $y = 3$.
3. $2x + 11z = 152$. $x = 10$; $z = ?$.
4. $14x + 7y = 98$. $x = 3\frac{1}{2}$; $y = ?$.

5. $\frac{3}{4}x + \frac{3}{4}z = 40.$ $z = 32.$
6. $9x - 25y = 8.$ $x = 12.$
7. $3\frac{1}{2}y + 4\frac{1}{3}z = 60.$ $z = 9.$
8. $16x - 19z = 49.$ $z = 5.$
9. $7y - 3z = 18.$ $y = 6\frac{1}{2}.$
10. $32x + 50y = 2600.$ $y = 20.$

552. Written Problems.

1. The cost of 3 apples and 2 peaches is 7 cents. The cost of 2 apples and 2 peaches is 6 cents.

Subtracting the second lot of fruit from the first lot we have 1 apple.

Subtracting the price of the second lot from the price of the first lot we have 1 cent. 1 apple costs 1 cent.

If equals are subtracted from equals, the remainders are equal.

2. A boy gave 25¢ for 3 lemons and 8 oranges, another boy paid 17¢ for 3 lemons and 4 oranges. How much did the lemons cost apiece?

$$x = \text{cost of lemons}, \quad 3x + 8y = 25 \quad (1)$$

$$y = \text{cost of oranges}, \quad 3x + 4y = 17 \quad (2)$$

$$\begin{array}{r} \text{Subtracting (2) from (1),} \\ \hline 4y = 8 \end{array}$$

$$\begin{array}{r} \text{The oranges cost } 2\text{¢ each,} \\ \hline y = 2. \end{array}$$

How much apiece was paid for the lemons?

3. If 3 coats and 14 vests cost \$78, and 2 coats and 14 vests, at the same rate, cost \$66, how much does 1 coat cost? What is the price of a vest?

$$4. \text{ Given} \quad 4x + 7y = 53, \quad (1)$$

$$2x + 3y = 25, \quad (2)$$

to find the value of $y.$

First multiply (2) by 2, making it $4x + 6x = 50.$ Why?

5. What is the value of x in equation (1) in above example, when the value found for y is substituted therein? Substitute the same value for y in equation (2) and find the value of $x.$

553. Written Exercises.

Find the values of x and y in the following equations:

1. $x + y = 15,$

$$2x + 3y = 38.$$

2. $2x + 2y = 30,$

$$x + 3y = 27.$$

3. $2x + 3y = 18,$

$$4x + 3y = 24.$$

4. $2x + 3y = 40,$

$$3x + 2y = 35.$$

Multiply first equation by 3, $6x + 9y = 120.$

Multiply second equation by 2, $6x + 4y = 70.$

5. $7x + 5y = 82,$

$$2x + 3y = 36.$$

6. $5x + 9y = 14,$

$$9x + 5y = 14.$$

7. $3x + 5y = 17,$

$$8x + 2y = 17.$$

8. $2x - 3y = 18,$

$$3x + 5y = 65.$$

Given $\begin{cases} (1) \quad x + 3y = 46, \\ (2) \quad 7x - 4y = 22. \end{cases}$ To find values of x and $y.$

Multiply (1) by 7, $7x + 21y = 322$

$$(2) \quad \underline{7x - 4y = 22} \quad \text{Subtract.}$$

$$25y = 300$$

$$y = 12$$

Substituting this value of y in (1), we have

$$x + 36 = 46,$$

$$x = 46 - 36 = 10. \quad \text{Ans. } x = 10, y = 12.$$

9. $x + y = 18,$ Add or subtract.

$$x - y = 4.$$

10. $4x + 3y = 17,$ (1) Multiply (2) by 2 and subtract.

$$2x - y = 1. \quad (2)$$

11. $3x + 4y = 48,$ Add.

$$x - 4y = 0.$$

12. $3x + 5y = 13,$ (1) Multiply (1) by 7 and (2) by 3.

$$7x + 3y = 13. \quad (2) \quad \text{Subtract.}$$

13. $4x + 5y = 32$, Add.

$$6x - 5y = -2.$$

14. $3x + 4y = 3$, (1) Multiply (2) by 2. Add.

$$12x - 2y = 3. \quad (2)$$

15. $5x = 6y + 5$, Transpose.

$$3x = 5y - 4.$$

16. $3x + 5y + 8 = 0$,

$$2x - y - 12 = 0.$$

17. $y - 2x = 8x - 1$,

$$2y - 4x = y + x + 9.$$

18. $5x + 7y = 55$,

$$9x + 18y = 126.$$

(1)

(2)

Divide (2) by 9 getting $x + 2y = 14$.

(3)

Then multiply (3) by 5.

19. $\frac{x}{4} + \frac{2y}{3} = 17$. Clear of fractions.

$$\frac{5x}{4} + \frac{5y}{8} = 20.$$

20. $\frac{1}{2}x + \frac{1}{3}y = 42$,

$$\frac{1}{3}x + \frac{1}{2}y = 17\frac{1}{2}.$$

24. $4\frac{1}{4}x + 3\frac{1}{3}y = 67$,

$$7\frac{1}{2}x - 5\frac{1}{3}y = 12.$$

21. $23x - 7y = 3x + 51$,

$$11y = 15x + 2.$$

25. $3(x + 7) = 9(y - 9)$,

$$4(3x - 8) = 17y - 155.$$

22. $x + y = 100,000$,

$$\frac{5x}{100} + \frac{4y}{100} = 4,640.$$

26. $2(x - 11) - 2(y - 9) = 6$,

$$\frac{x+9}{y-3} = \frac{32}{15}.$$

23. $\frac{3x+7}{3y-4} = 5$,

$$\frac{x-4}{3} + \frac{y-1}{4} = 5,$$

$$\frac{7x-6}{5y+3} = 2.$$

$$\frac{x-4}{3} - \frac{y-1}{4} = 1.$$

28. $\frac{2x+5y+3}{3x-4y-2} = 6$,

$$\frac{4x-7y+5}{x-2y+2} = 5.$$

554. Written Problems.

1. The sum of two numbers is 37. Twice the first added to three times the second is 96. What are the numbers?

Let x = first number; y = second number.

2. The difference between two numbers is 28. Five times the first less twice the second is 197. What are the numbers? $x - y = 28$; $5x - 2y = 197$.

3. The product of the first of two numbers by 5, added to the product of the second by 3, gives 37. The product of the first by 6, diminished by five times the second, equals 10. Find the numbers.

4. Divide 65 into two parts whose difference shall be 19.

Let x and y = parts. Solve also by one unknown quantity.

5. A person pays \$103 with 32 bills, some of them \$2 bills, the others \$5 bills. How many of each does he use?

6. For 25 head of pigs and sheep, a farmer received \$145. How many of each did he sell, if he sold the former at \$7 each, the latter at \$5 each?

7. 10 oranges and 4 peaches cost 38¢; 6 oranges and 7 peaches cost 32¢. Find the cost of an orange. Of a peach.

8. 5 pounds of tea and 3 pounds of coffee cost \$3.75; 8 pounds of tea and 1 pound of coffee cost \$5.05. What is each worth per pound?

9. A farmer buys a certain number of horses at \$125 each and a certain number of cows at \$40 each. They cost together \$740. If he had bought half as many horses and twice as many cows they would have cost \$730. How many of each did he buy?

10. A man paid 75¢ for 2 pounds of raisins and 3 pounds of cheese. 5 pounds of raisins and 2 pounds of cheese at the same prices would have cost 94¢. What did each cost per pound?

11. The sum of two numbers is 19. The sum of the second number and ten times the first, minus the sum of the first and ten times the second, equals 45. What are the numbers?

12. Reduce $\frac{5}{18}$ to an equivalent fraction, the sum of whose numerator and denominator shall be 126.

$$x = \text{numerator}; y = \text{denominator}.$$

$$\frac{x}{y} = \frac{5}{13}; x + y = 126.$$

13. What fraction equivalent to $\frac{8}{15}$ has 147 for the difference between its numerator and denominator?

$$x - y = -147. \text{ Why?}$$

14. 10 pounds of coffee at 30¢ per pound are mixed with x pounds of coffee at 25¢ per pound. What is x equal to, when the mixture is worth 26¢ per pound?

$$25x + (10 \times 30) = 26(10 + x).$$

15. A grocer mixes green tea costing 60¢ per pound with black tea costing 40¢ per pound. He uses 100 pounds in all, and the mixed tea costs him 48¢ per pound. How many pounds of each does he use?

Let x = number of pounds of black tea; y = number of green. Then $x + y$ = number of pounds of mixed tea.

$$x + y = 100; 40x + 60y = 48(x + y).$$

THREE UNKNOWN QUANTITIES.

555. 1. Given the following:

$$3x + 2y - z = 12, (a)$$

$$5x - 4y + 3z = 16, (b)$$

$$2x + 3y + 2z = 35, (c)$$

to find the values of x , y , and z .

$$\begin{array}{l}
 (a) \text{ multiplied by } 5, \quad 15x + 10y - 5z = 60 \\
 (b) \text{ multiplied by } 3, \quad 15x - 12y + 9z = 48 \\
 \hline
 \text{Subtract,} \quad 22y - 14z = 12 \quad (d)
 \end{array}$$

an equation containing only two unknown quantities.

$$\begin{array}{l}
 (b) \text{ multiplied by } 2, \quad 10x - 8y + 6z = 32 \\
 (c) \text{ multiplied by } 5, \quad 10x + 15y + 10z = 175 \\
 \hline
 \text{Subtract,} \quad -23y - 4z = -143 \quad (e)
 \end{array}$$

an equation containing only two unknown quantities.

Compare the two equations (d) and (e), which contain the same two unknown quantities.

$$\begin{array}{l}
 (d) \text{ multiplied by } 2, \quad 44y - 28z = 24 \\
 (e) \text{ multiplied by } 7, \quad -161y - 28z = -1001 \\
 \hline
 \text{Subtract,} \quad 205y = 1025 \\
 \qquad \qquad \qquad y = 5
 \end{array}$$

Substituting this value of y in (d), we have

$$110 - 14z = 12, \quad -14z = -98, \quad z = 7.$$

Substituting values of y and z in (a), we have

$$8x + 10 - 7 = 12, \quad 3x = 9, \quad x = 3.$$

$$\left. \begin{array}{l} \text{Ans. } x = 3, \\ y = 5, \\ z = 7. \end{array} \right\}$$

2. Find the values of the unknown quantities in the following equations:

$$x - 3y + 2z = 3, \quad (a)$$

$$2x + y + 3z = 22, \quad (b)$$

$$5x + 2y + 7z = 51. \quad (c)$$

Multiply (a) by 2, and subtract from (b). Multiply (a) by 5, and subtract from (c). This gives two equations, each of which contains two unknown quantities.

Compare these two resulting equations, and eliminate y .

3. $5x - 2y + z = 10$, (a)

$3x + 8y - 5z = 120$, (b)

$7x - 3y - 2z = 8$. (c)

Eliminate z by comparing (a) and (b), multiplying the former by 5.
Compare (a) and (c), multiplying the former by 2.

4. $13x - 4y + 15z = 317$,

$7x + 2y - 3z = 89$,

$21x - 17y + 9z = -104$.

5. $-8x + y - 12z = -259$,

$7x - 4y + 25z = 418$,

$13x + 2y - 41z = -500$.

6. $\frac{x}{3} + \frac{x+y}{3} = 14$,

$\frac{x+y}{2} - \frac{x-y}{6} = 16$.

7. $\frac{3x-5y}{2} + 3 = \frac{2x+y}{5}$,

$8 - \frac{x-2y}{4} = \frac{x}{2} + \frac{y}{3}$.

8. $2 + \frac{5x-6y}{13} = 4y - 3x$,

$12 + \frac{5x-6y}{6} = 2y + \frac{3x-2y}{4}$.

9. $\frac{5x-3}{4} - \frac{3x-19}{4} = 2 - \frac{3y-x}{6}$,

$\frac{2x+y}{2} - \frac{9x-7}{8} = \frac{3y+9}{4} - \frac{4x+5y}{16}$.

556. Written Problems.

1. A man placed $\frac{2}{3}$ of his capital at 5% and the other third at 6%. At the end of a year, capital and interest amounted to \$31,600. What was his capital?

$$\frac{2x}{3} \times \frac{5}{100} \text{ and } \frac{x}{3} \times \frac{6}{100} = \text{interest.}$$

2. A has 18 chestnuts more than B. If each finds 4 more, A will have four times as many as B. How many chestnuts has each?

3. Two mechanics earn together \$8 per day. One works 23 days and the other 17 days, for which they receive together \$166. What does each earn per day?

4. The sum of the first and the second of three numbers is 55, of the first and the third 62, of the second and the third 83. What are the numbers?

SUGGESTION. — Add together the three equations.

5. The sum of two numbers is 53. Four times the first is 20 more than twice the second. Find the numbers.

6. A certain sum of money is divided among four persons. The first takes $\frac{1}{5}$ of it, the second takes $\frac{1}{4}$ of the remainder, the third takes $\frac{1}{3}$ of what then remains, the fourth receives the balance, \$24. What is the share of each of the other three?

7. A merchant sold a lot of goods for \$510, thereby losing $\frac{3}{20}$ of their cost. What did the goods cost?

8. A man collected a bill for a physician and deducted $\frac{1}{10}$ of the amount for his services. If he gave the physician \$147, what was the amount collected?

9. Divide $130\frac{1}{4}$ acres of land among three persons, giving the first $27\frac{1}{2}$ acres more than the second, and the second $13\frac{1}{4}$ acres more than the third.

10. A merchant has sold $\frac{4}{7}$ of a piece of cloth, and has remaining 16 yards more than $\frac{1}{3}$ of the piece. How many yards did the piece contain originally?

11. A servant is engaged for a year for \$280 and a suit of clothes; he leaves at the end of six months, and receives \$130 and the suit. What is the value of the clothes?

$$\text{Yearly wages} = 280 + x. \quad \text{Wages for six months} = 140 + \frac{x}{2} = 130 + x.$$

EXONENTS.

557. (1) x^2 means x times x , or xx .

(2) y^3 means y times y times y , or yyy .

(3) a^4 means $aaaa$.

In (1) 2 is an exponent.

In (2) 3 is an exponent.

In (3) 4 is an exponent.

Notice that the exponent is written above the quantity to which it belongs.

On which side of the quantity is it written?

How many times is the quantity used as a factor if the exponent is 2? If the exponent is 3? If the exponent is 5?

Tell two facts concerning the location of the exponent.
Tell one fact concerning the meaning of the exponent.

What is an exponent?

NOTE. — When no exponent is written, 1 is understood.

558. Oral Exercises.

If $a = 2$, and if $b = 3$, and if $c = 5$,

1. $a^2 = ?$

7. $a^3 + a^3 + a = ?$

2. $a^2 + a = ?$

8. $a^3 + b^3 + c = ?$

3. $a^2 + b + c = ?$

9. $a^4 + b^3 + c^2 = ?$

4. $a^2 + b^2 = ?$

10. $a^2 + ? c = 19.$

5. $b^2 - a^2 = ?$

11. $a^3 + b^3 = a^2 + b^2 + c^2 - ?$

6. $a^2 + 2 ab + b^2 = ?$

12. $b^2 + a^4 = c^2.$

559. $3b^3$ means $3b$ times b and *not* $3b$ times $3b$. The exponent 2 belongs to the letter b and *not* to the expression $3b$.

ab^3 means $abbb$ and *not* $ababab$.

In $5ab^3$ to what part of the expression does the exponent belong?

If we use a parenthesis, the effect is different. $(3b)^3$ means $3b$ times $3b$. $(ab)^3$ means $ababab$.

What does $(2a)^4$ mean?

560. Oral Exercises.

If $a = 2$, and if $b = 3$, and if $c = 5$,

- | | |
|------------------------|-------------------------------|
| 1. $5a^2 = ?$ | 7. $7ab^2 = ?$ |
| 2. $(5a)^2 = ?$ | 8. $7a^2b = ?$ |
| 3. $(2b)^3 - 2b^2 = ?$ | 9. $abc^2 = ?$ |
| 4. $4b^2 - c^2 = ?$ | 10. $a^2b^2c = ?$ |
| 5. $(3a)^3 - 3a^3 = ?$ | 11. $c^2 - a^2 = ? (c - a)$. |
| 6. $abc^2 = ?$ | 12. $4b^3 - 2ac = a^2$. |

MULTIPLICATION.

561. What coefficient is understood when none is written? What exponent is understood when none is written?

$$2a \text{ times } 3 = 6a.$$

$$2a \text{ times } 3a = 6a^2.$$

$$3a \text{ times } 4a = 12a^2.$$

$$5a^2 \text{ times } 2a = 10a^3.$$

$$5a \text{ times } 2b = 10ab.$$

Multiply together the numerical coefficients and affix all the letters, giving each letter the sum of the exponents of that letter in both factors.

562. Oral Exercises.

Multiply:

- | | |
|------------------------|----------------------------------|
| 1. $3a$ by $5a$. | . 7. $5a^2b$ by $3c$. |
| 2. $2ab$ by $3a$. | 8. $5ab$ by $3ac$. |
| 3. $2ab$ by $3b$. | 9. $5ab$ by $3ab^2c^2$. |
| 4. $2a^2b$ by $3a$. | 10. ab^2c^3 by abc . |
| 5. $2ab^2$ by $3a$. | 11. $\frac{1}{2}ab$ by $6a^2$. |
| 6. $2a^2b^3$ by $3b$. | 12. $10a^2b$ by $\frac{1}{3}a$. |

SIGNS IN MULTIPLICATION.

563. Preliminary Exercises.

1. $+a$ times $+b = +ab$.

Here the two factors, $+a$ and $+b$, have like signs (both are $+$). The product has the $+$ sign.

2. $-a$ times $-b = +ab$.

Here the two factors have like signs (both are $-$). The product has the $+$ sign.

3. $-a$ times $+b = -ab$.

Here the two factors have unlike signs (one $+$ and one $-$). The product has the $-$ sign.

4. $+a$ times $-b = -ab$.

Here the two factors have unlike signs. The product has the $-$ sign.

From the above we may see the law for signs in multiplication.

Like signs give $+$.

Unlike signs give $-$.

Multiply:

- | | |
|-----------------------|------------------------|
| 5. $-3a$ by $5a$. | 9. $-5a^2b$ by $-3c$. |
| 6. $2a$ by $4a$. | 10. $-5a^2b$ by $3c$. |
| 7. $-2a$ by $-4a$. | 11. $5a^2b$ by $-3c$. |
| 8. $2ab^2$ by $-3a$. | 12. $-5a^2b$ by -1 . |

564. Written Exercises.

Multiply :

- | | |
|------------------------------|-----------------------------------|
| 1. $a^2 + 3a$ by $2a$. | <i>Ans.</i> $2a^3 + 6a^2$. |
| 2. $4a - b$ by $2ab$. | <i>Ans.</i> $8a^3b - 2ab^2$. |
| 3. $5a + 3b$ by $4a$. | 8. $a^2 - b^2$ by a . |
| 4. $ax - cx$ by $-3a$. | 9. $a^2 - b^2$ by $-a$. |
| 5. $a^2 + a + 1$ by a . | 10. $ab^2c^3 - a$ by ab . |
| 6. $a^2 + 2a + 1$ by $-2a$. | 11. $a^3 + 2ab + b^2$ by $2ab$. |
| 7. $a^2 + a + 1$ by ab . | 12. $a^3 - 2ab + b^2$ by $-2ab$. |

565. Written Exercises.

1. Multiply
- $x + 2$
- by
- $x + 3$
- .

$$\begin{array}{r}
 x+2 \\
 \times x+3 \\
 \hline
 x^2+2x \\
 + 3x+6 \\
 \hline
 x^2+5x+6
 \end{array}$$

Multiplying $x + 2$ by x ,
 Multiplying $x + 2$ by 3,
 Adding the two parts of the product,

Multiply each term of the multiplicand by each term of the multiplier and combine the products.

2. Multiply
- $x + 3$
- by
- $x - 4$
- .

$$\begin{array}{r}
 x+3 \\
 \times x-4 \\
 \hline
 x^2+3x \\
 - 4x-12 \\
 \hline
 x^2-x-12
 \end{array}$$

Multiply :

- | | |
|--------------------------|---------------------------|
| 3. $x + 3$ by $x + 4$. | 7. $2x - 8$ by $x + 9$. |
| 4. $x + 5$ by $x - 2$. | 8. $3x + 1$ by $x + 7$. |
| 5. $x + 8$ by $x - 9$. | 9. $2x + 1$ by $2x + 1$. |
| 6. $2x + 5$ by $x + 2$. | 10. $x - 5$ by $x + 4$. |

566. Written Exercises.

Find products :

NOTE : $(x - 3)(x + 9)$ means $x - 3$ multiplied by $x + 9$.

- | | |
|------------------------|-------------------------|
| 1. $(x - 3)(x + 9).$ | 13. $(x - 5)(x - 9).$ |
| 2. $(x - 6)(x + 7).$ | 14. $(x + 5)(x + 5).$ |
| 3. $(x - 5)(x + 5).$ | 15. $(x - 3)(x + 8).$ |
| 4. $(x + 5)(x - 5).$ | 16. $(x + 7)(x - 6).$ |
| 5. $(2x - 6)(x + 1).$ | 17. $(x - 4)(x - 7).$ |
| 6. $(x - 6)(2x + 1).$ | 18. $(2x - 4)(3x - 6).$ |
| 7. $(2x - 6)(3x + 3).$ | 19. $(2x + 6)(3x - 7).$ |
| 8. $(3x + 6)(2x - 3).$ | 20. $(2x + 7)(3x + 3).$ |
| 9. $(2x + 3)(2x - 3).$ | 21. $(2x - 3)(3x - 2).$ |
| 10. $(x - 5)(x - 4).$ | 22. $(2x - 3)(2x + 3).$ |
| 11. $(x - 7)(x - 9).$ | 23. $(2x + 9)(4x - 6).$ |
| 12. $(x - 7)(x - 7).$ | 24. $(3x - 4)(3x + 4).$ |

567. Written Exercises.

1. Multiply
- $x + y$
- by
- $x + y$
- .

$$\begin{array}{r} x + y \\ x + y \\ \hline x^2 + xy \\ \quad \quad \quad xy + y^2 \\ \hline x^2 + 2xy + y^2 \end{array}$$

Multiply :

- | | |
|-------------------------------|-------------------------------|
| 2. $a + b$ by $a + b.$ | 4. $a + 3x$ by $a + 3x.$ |
| 3. $a - y$ by $a - y.$ | 5. $2a + x$ by $a + 2x.$ |
| 6. $x + y$ by $x - y.$ | Ans. $x^2 - y^2.$ |
| 7. $a + 1$ by $a - 1.$ | 9. $a^2 + b$ by $a^2 + b.$ |
| 8. $m + n$ by $m - n.$ | 10. $a^2 + b^2$ by $a - b.$ |
| 11. $a^2 + a + 1$ by $a - 1.$ | Ans. $a^3 - 1.$ |
| 12. $a^2 - a + 1$ by $a + 1.$ | 13. $x^2 + x + 1$ by $x - 1.$ |

TERMS.

568. Preliminary Exercises.

- | | |
|----------------------|------------------------|
| 1. $2abc$. | 3. $a^3 + 2ab + b^3$. |
| 2. $2 + a + b + c$. | 4. $7ab^3 - 1$. |

The first of the above expressions has one term

The second has 4 terms.

The third has 3 terms.

The fourth has 2 terms.

An expression containing one term is called a monomial; one containing two terms, a binomial; one containing three terms, a trinomial; one containing four or more, a polynomial.

How many terms has each of the following?

- | | |
|---------------------|-------------------------|
| 5. $2acx^2y$. | 8. $11a^3 + a$. |
| 6. $a + 1$. | 9. $a^2 + a + abc$. |
| 7. $a^3 + a + 11$. | 10. $a^3 + a + b + c$. |

LIKE TERMS.

569. Like terms are those containing the same letters and the same exponents for each letter.

570. Oral Exercises.

Which of the following expressions contain like terms?

- | | |
|------------------------|----------------------------|
| 1. a and b . | 6. $2a^3$ and $2a^3$. |
| 2. $2a$ and a . | 7. $2a^3b$ and $3a^3b$. |
| 3. a^3 and a . | 8. $2a^3b$ and $3a^3b$. |
| 4. a^3 and $2a$. | 9. xy^3 and x^3y . |
| 5. $2a^3$ and $3a^3$. | 10. $5ax^3y$ and ax^3y . |

COMBINING LIKE TERMS.

571. Two or more like terms may be combined into a single term. Unlike terms cannot be so combined.

572. Written Exercises.

Combine when possible:

$$1. \quad 3abc^2 - abc + abc^2 = 4abc^2 - abc.$$

The first and third terms are combined.

$$2. \quad 3abc^2 - ab^2c + a^2bc.$$

$$3. \quad 3abc - 2abc + abc.$$

$$4. \quad 2abx - ab + 3bx.$$

$$5. \quad a^3 - a^2 + 2a - 4 + 3a^2 - a.$$

$$6. \quad 4a^3 - 2ab + b^2 + a^2 - b^2.$$

$$7. \quad 8x^2y - xy + x - xy - 3x.$$

$$8. \quad 4m^2 + 4mn + n^2 - mn^2.$$

573. Written Exercises.

$$1. \quad (a^3 + b)(a + b) = ?$$

- Multiplying by a , we have $a^4 + ab$. Multiplying a^2 by b , gives a^2b . As there is no like term, this product is placed after ab . The product of b by b is placed last.

$$\begin{array}{r} a^3 + b \\ a + b \\ \hline a^4 + ab + a^2b + b^2 \end{array}$$

Rearrange the terms in the order of the size of the exponents of a .

$$Ans. \quad a^4 + a^2b + ab + b^2.$$

2. $(2ab - b)(b - 1) = ?$
3. $(2ab - b)(2a - 1) = ?$
4. $(2ab - b)(ab - b) = ?$
5. $(a^2 - b^2)(a + b) = ?$
6. $(a + b)(c + d) = ?$
7. $(3a + b)(a - ab) = ?$
8. $(2pq - x)(2pq + x) = ?$
9. $(x^3 + 4y^2)(4x - y) = ?$
10. $(x^2 + x - 2)(x - 2) = ?$

DIVISION.

574. Preliminary Exercises.

- | | |
|---|---------------------------|
| 1. $6a + 3 = 2a$. | 4. $5a^3x + 5a^3 = x$. |
| 2. $a^2 + a = a$. | 5. $10a^2x + 5x = 2a^2$. |
| 3. $6a^2 + 3a = 2a$. | 6. $10a^2x + 2ax = 5a$. |
| 7. $(12a^3xy^2 - 27a^2x^2y) \div 3a^2xy = 4ay - 9x$. | |

In the above examples what is done with the coefficients ?
What is done with the exponents of the same letter ?

When the divisor is a monomial, divide the numerical coefficient of each term of the dividend by the numerical coefficient of the divisor. Then write the letters of the dividend, giving each an exponent equal to the exponent in the dividend diminished by that in the divisor.

575. Like signs give +. Unlike signs give -.

576. Written Exercises.

Divide:

- | | |
|---|-------------------------------|
| 1. $5a^3$ by a^2 . | 4. $-x^3y^3$ by $-xy^2$. |
| 2. $-x^3y^3$ by xy^2 . | 5. $x^3 + 2xy$ by x . |
| 3. x^3y^3 by $-xy^2$. | 6. $x^3 - 5x^2 + 3x$ by x . |
| 7. $15x^4 - 10x^3 + 20x^2$ by $-5x^2$. | |
| 8. $4x^3y^3 - 3x^2y + xy^2$ by xy . | |
| 9. $-12x^3y^2 + 33x^2y^3 - 24xy^4$ by $-3xy^2$. | |
| 10. $-7x^5$ by $-7x^4$. | |
| 11. $7x^5$ by $-7x^5$. | |
| 12. $a^3 + a$ by $\frac{1}{2}a$. | <i>Ans.</i> $2a + 2$. |
| 13. $x^3 + 3x^2$ by $-\frac{1}{3}x$. | |
| 14. $6a^3 - 3a^2$ by $-9a^2$. | |
| 15. $-x + xy - xz$ by $-x$. | |
| 16. $\frac{1}{3}x^3y - 2x^2y^3$ by $-\frac{1}{2}x^2y$. | |

577. Written Exercises.

1. Divide $x^2 + 7x + 12$ by $x + 3$.

We write a division like the above as follows :

$$\begin{array}{r} x^2 + 7x + 12 \\ \hline x + 3 \end{array}$$

The first term in the divisor is x .

The first term in the dividend is x^2 .

Dividing x^2 by x we get x for the first term of the quotient, which we put down thus,

$$\begin{array}{r} x^2 + 7x + 12 \\ \hline x \end{array}$$

then we multiply the divisor by the first term of the quotient and write the result under the dividend.

$$\begin{array}{r} x^2 + 7x + 12 \\ (x+3) \text{ } x \text{ times} \quad x^2 + 3x \\ \hline x \end{array}$$

Next, we subtract $x^2 + 3x$ from the dividend,

$$\begin{array}{r} x^2 + 7x + 12 \\ \text{subtract} \quad x^2 + 3x \\ \hline \text{remainder} \quad 4x + 12 \end{array}$$

Next, we divide the first term of the remainder by the first term of the divisor and get $+4$, which we write in the quotient thus,

$$\begin{array}{r} x^2 + 7x + 12 \\ x^2 + 3x \\ \hline 4x + 12 \end{array}$$

Next, we multiply the divisor by 4 and write the product thus,

$$\begin{array}{r} x^2 + 7x + 12 \\ x^2 + 3x \\ \hline 4x + 12 \\ (x+3) \text{ } 4 \text{ times} \quad 4x + 12 \end{array}$$

Subtracting, there is no remainder. The whole quotient is $x + 4$.

$$\begin{array}{r} x^2 + 7x + 12 \\ x^2 + 3x \\ \hline 4x + 12 \\ 4x + 12 \\ \hline 0 \end{array}$$

Ans.

2. Divide $x^2 + 18x + 56$ by $x + 4$.

$$\begin{array}{r} x^2 + 18x + 56 \\ \underline{x^2 + 4x} \\ 14x + 56 \\ \underline{14x + 56} \\ 0 \end{array} \quad \text{Ans.}$$

3. Divide $a^2 - 2ab - 24b^2$ by $a + 4b$.

$$\begin{array}{r} a^2 - 2ab - 24b^2 \\ \underline{a^2 + 4ab} \\ - 6ab - 24b^2 \\ \underline{- 6ab - 24b^2} \\ 0 \end{array} \quad \text{Ans.}$$

Prove that the answers in the above examples are correct.

578. Written Exercises.

Divide:

1. $x^2 + 5x + 6$ by $x + 3$.
2. $x^3 + 5x^2 + 6x$ by $x + 3$.
3. $x^3 + 5x^2 + 6x$ by $x^2 + 3x$. Ans. $x + 2$.
4. $x^2 + 7xy + 10y^2$ by $x + 2y$.
5. $x^2 - 7xy + 10y^2$ by $x - 2y$.
6. $3x^2 + 14xy + 8y^2$ by $x + 4y$.
7. $3x^2 + 10xy - 8y^2$ by $x + 4y$.
8. $3x^2 - 10xy - 8y^2$ by $x - 4y$.
9. $3x^2 - 14xy + 8y^2$ by $x - 4y$.
10. $3x^2 + 10xy - 8y^2$ by $3x - 2y$.
11. $8x^3 + 22xy + 15y^3$ by $2x + 3y$.
12. $8x^3 - 2xy - 15y^3$ by $4x + 5y$.
13. $8x^3 - 22xy + 15y^3$ by $4x - 5y$.
14. $n^2x^2 + 3anx + 2a^2$ by $nx + a$. Ans. $nx + 2a$.
15. $n^2x^2 + anx - 2a^2$ by $nx - a$.
16. $6a^3b^2 - 13abw + 6w^3$ by $3ab - 2w$.
17. $4x^3 + 2xyz - 132y^2z^2$ by $2x - 11yz$.

18. $4ax^3 + 2axyz - 132ay^2z^3$ by $2x - 11yz$.

19. $8ax^3 - 26axyz + 15ay^2z^3$ by $4ax - 3ayz$.

579. Written Exercises.

1. Divide $x^3 - 1$ by $x - 1$.

$$\begin{array}{r|l} x^3 - 1 & x - 1 \\ \hline x^3 - x^2 & x^2 + x + 1 \quad \text{Ans.} \\ \hline x^2 - 1 \\ \hline x^2 - x \\ \hline x - 1 \\ \hline x - 1 \\ \hline 0 \end{array}$$

2. Divide $x^3 - 13x - 10 - 2x^2$ by $x - 5$.

The terms of the dividend should be arranged according to the size of the exponents of x , thus, $x^3 - 2x^2 - 13x - 10$.

$$\begin{array}{r|l} x^3 - 2x^2 - 13x - 9 & x - 5 \\ \hline x^3 - 5x^2 & x^2 + 8x + 2 + \frac{1}{x-5} \\ \hline 3x^2 - 13x - 9 \\ \hline 3x^2 - 15x \\ \hline 2x - 9 \\ \hline 2x - 10 \\ \hline + 1 \end{array}$$

Divide:

3. $a^3 - b^3$ by $a - b$.

5. $c^3 + 1$ by $c + 1$.

4. $c^3 - 1$ by $c - 1$.

6. $9a^4 - 16b^2$ by $3a^2 + 4b$.

7. $c^3 + 2$ by $c + 1$.

Ans. $c^2 + c + 1 + \frac{1}{c+1}$.

8. $x^3 + 6x^2y + 12xy^2 + 8y^3$ by $x + 2y$.

9. $a^3 + 3a - 3a^2 - 1$ by $a - 1$. Rearrange dividend.

10. $x^3 + 27y^3$ by $x + 3y$.

11. $a^2 + 2ab + b^2 - 1$ by $a + b + 1$. Ans. $a + b - 1$.

12. $12a^3 - 20a^2 + 33a - 5$ by $6a - 1$.

13. $8ab^3 - 125ax^3y^3$ by $2ab - 5axy$.

14. $1 + 5a^3 - 6a^4$ by $1 - a + 3a^2$.

15. $6x^5 + x - 12x^3 + 9x^3 - 3 - 11x^4$ by $2x^3 - 3x^2 - 1$.

FACTORING.

580. The expression $x + xy$ may be divided by x ; the quotient is $1 + y$. The factors of $x + xy$ are x and $1 + y$; that is, $(x + xy) = x(1 + y)$.

In a similar manner we find that the factors of $2a^3b + 4ab^3$ are $2ab$ and $a + 2b$; that is, $2a^3b + 4ab^3 = 2ab(a + 2b)$.

581. Factor:

- | | | |
|--------------------------------------|-------------------------------------|----------------------|
| 1. $m + mn.$ | 4. $a^3 + a^4.$ | 7. $c^3 + c^2 + c.$ |
| 2. $m^2n + 2m.$ | 5. $6b^3 - 9b^2.$ | 8. $7a^3b + 21a^2c.$ |
| 3. $6x^3y - 3xy^3.$ | 6. $a^3b + 6ab^3.$ | 9. $4x^4 + 6x^3.$ |
| 10. $4x^4 + 6x^3 + 8x^2.$ | 18. $20ax^2 - 15bx^3 + 16cx^4.$ | |
| 11. $4x^4 + 6x^3 + 8x^2 + 10x.$ | 19. $20ax^3 + 15a^2x^3 - 20a^3x^4.$ | |
| 12. $4x^4 + 6x^3 + 8x^2 + 10x + 12.$ | 20. $a^5x^3 + a^4x^4.$ | |
| 13. $12ab^3 - 9ac^3 + 6ac^2.$ | 21. $6a^2 + 4a^4 + 2a^6.$ | |
| 14. $3ab^2 + 2a^3b + 2a^3.$ | 22. $a^3x^4 + a^3x^3 + a^4x^4.$ | |
| 15. $3a^2b + 6ab^2 - 15ab^3.$ | 23. $12m^3n + 5m^2n^2 + 15ny.$ | |
| 16. $x^3y^2z + xyz^3.$ | 24. $a^7 - a^5b^2 + a^4c^3.$ | |
| 17. $9m^2n^3x - 27m^4n^2y.$ | 25. $70x^7 + 60x^6 - 50x^5.$ | |

582. The square of $x + y$ is $x^2 + 2xy + y^2$.

Note that x^2 and y^2 are the squares of x and y , respectively, and that $2xy$ is twice the product of x and y .

The square of the sum of two quantities is equal to the square of the first, plus twice the product of the first and the second, plus the square of the second.

Any expression in the form of $x^2 + 2xy + y^2$ is composed of two equal factors:

$$a^2 + 2ab + b^2 = (a + b)(a + b) \text{ or } (a + b)^2.$$

583. Factor:

- | | |
|------------------------------|---------------------------------|
| 1. $c^2 + 2cd + d^2$. | 14. $c^3d^3 + 6cdm + 9m^2$. |
| 2. $m^2 + 2m + 1$. | 15. $4a^2 + 12a + 9$. |
| 3. $4 + 4w + w^2$. | 16. $9a^2 + 12ab + 4b^2$. |
| 4. $a^2x^2 + 2axy + y^2$. | 17. $4a^2 + 4ac + c^2$. |
| 5. $r^2 + 2rst + s^2t^2$. | 18. $a^4 + 2a^2b + b^2$. |
| 6. $e^2 + 6e + 9$. | 19. $a^2 + 2abx + b^2x^2$. |
| 7. $x^2 + 8x + 16$. | 20. $a^3b^3 + 2abcd + c^2d^2$. |
| 8. $4b^2 + 4bd + d^2$. | 21. $m^2n^2 + 10mn + 25$. |
| 9. $a^2 + 4ay + 4y^2$. | 22. $9b^2 + 30bc + 25c^2$. |
| 10. $a^2 + 4ayz + 4y^2z^2$. | 23. $16 + 16xy + 4x^2y^2$. |
| 11. $4a^2x^2 + 4abx + b^2$. | 24. $x^4 + 2x^2y^2z + y^4z^2$. |
| 12. $u^2 + 6uv + 9v^2$. | 25. $a^2b^2 + 12abc + 36c^2$. |
| 13. $a^4 + 2a^2b^2 + b^4$. | 26. $4m^2 + 8mn + 4n^2$. |

584. The square of $a - b$ is $a^2 - 2ab + b^2$.

Compare this form with that of Article 582, and note the difference in signs.

Give a general statement for the square of the difference of two quantities.

585. Factor:

- | | |
|------------------------------|---------------------------------|
| 1. $a^2 - 2ay + y^2$. | 14. $x^2 - 2x + 1$. |
| 2. $1 - 2x + x^2$. | 15. $4x^4 - 4x^2 + 1$. |
| 3. $m^2 - 2mnr + n^2r^2$. | 16. $4x^2 - 12xy + 9y^2$. |
| 4. $a^2 - 4a + 4$. | 17. $9y^2 - 12xy + 4x^2$. |
| 5. $9 - 6b + b^2$. | 18. $a^4 - 2a^2x + x^2$. |
| 6. $r^2s^2 - 2rst + t^2$. | 19. $9 - 12b + 4b^2$. |
| 7. $c^2 - 4cd + 4d^2$. | 20. $4x^2 + 4x + 1$. |
| 8. $16x^2 - 8x + 1$. | 21. $x^2 + 4y^2 - 4xy$. |
| 9. $4b^2 - 4bc + c^2$. | 22. $16x^2 - 40xz + 25z^2$. |
| 10. $a^2y^2 - 4ayz + 4z^2$. | 23. $b^4 - 2b^2cd^2 + c^2d^4$. |
| 11. $4a^2y^2 - 4ayz + z^2$. | 24. $25x^4 - 30x^2 + 9$. |
| 12. $9a^2 - 6ah + h^2$. | 25. $25x^2 - 30x^3 + 9x$. |
| 13. $b^2c^2 - 6bcd + 9d^2$. | 26. $50x^5 - 60x^3 + 18x$. |

586. The product of $a + b$ and $a - b$ is $a^2 - b^2$.

Give a general statement for the product of the sum and the difference of two quantities.

An expression consists of the difference of the squares of two quantities. What are the factors of the expression?

In factoring an expression first examine it to see if it contains a monomial factor. $b^2 - bc^2 = b(b^2 - c^2)$. The factors of $b^2 - c^2$ are $b + c$ and $b - c$. $b^2 - bc^2 = b(b + c)(b - c)$.

587. Factor:

- | | |
|-----------------------|-------------------------|
| 1. $m^2 - n^2$. | 12. $m^2 - 9n^2$. |
| 2. $1 - m^2$. | 13. $b^3 - 9b$. |
| 3. $x^2 - 4$. | 14. $9m^2 - n^2p^2$. |
| 4. $c^2 - d^2y^2$. | 15. $9b^2 - 4$. |
| 5. $9 - v^2$. | 16. $4c^2 - 9d^2$. |
| 6. $h^2 - 16$. | 17. $bc^2 - 4bd^2$. |
| 7. $4x^2 - y^2$. | 18. $a^4 - b^2$. |
| 8. $a^2x^2 - y^2$. | 19. $x^4 - y^2$. |
| 9. $x^2 - 4y^2$. | 20. $xy^3 - a^2b^2x$. |
| 10. $4a^2b^2 - w^2$. | 21. $x^2y^3 - a^2b^2$. |
| 11. $aw^2 - 4a$. | 22. $-m^2 + a^2x^2$. |

588. The product of $x + 2$ and $x + 3$ is $x^2 + 5x + 6$.

Note that the coefficient of the second term of the product is the sum of the second terms of the factors; $5 = 2 + 3$.

Note that the last term of the product is the product of the second terms of the factors; $6 = 2 \times 3$.

Factor $x^2 + 7x + 12$.

We must find two numbers whose sum is 7 and whose product is 12. These numbers are 3 and 4.

$$x^2 + 7x + 12 = (x + 3)(x + 4).$$

In a similar manner, we find

$$x^2 + 6x + 5 = (x + 1)(x + 5).$$

589. Factor :

- | | |
|-----------------------|-----------------------|
| 1. $x^3 + 4x + 3.$ | 14. $r^3 + 10r + 9.$ |
| 2. $m^3 + 6m + 8.$ | 15. $s^3 + 11s + 18.$ |
| 3. $b^3 + 7b + 10.$ | 16. $24 + 10a + a^2.$ |
| 4. $c^3 + 7c + 6.$ | 17. $v^3 + 11v + 24.$ |
| 5. $a^3 + 8a + 7.$ | 18. $20 + 12x + x^2.$ |
| 6. $a^3 + 9a + 14.$ | 19. $x^3 + 12x + 32.$ |
| 7. $y^3 + 8y + 12.$ | 20. $27 + 12x + x^2.$ |
| 8. $d^3 + 10d + 16.$ | 21. $a^3 + 14a + 24.$ |
| 9. $h^3 + 8h + 15.$ | 22. $c^3 + 20c + 19.$ |
| 10. $x^3 + 9x + 18.$ | 23. $y^3 + 12y + 35.$ |
| 11. $x^3 + 9x + 20.$ | 24. $m^3 + 13m + 30.$ |
| 12. $z^3 + 10z + 21.$ | 25. $x^3 + 11x + 30.$ |
| 13. $w^3 + 12w + 20.$ | 26. $f^3 + 10f + 9.$ |

590. The product of $x - 2$ and $x - 3$ is $x^2 - 5x + 6.$
 Compare with Article 588 and note the difference in signs. $a^2 - 11a + 10 = (a - 10)(a - 1).$

591. Factor :

- | | |
|----------------------|-----------------------|
| 1. $c^3 - 7c + 12.$ | 9. $n^3 - 14n + 45.$ |
| 2. $d^3 - 5d + 4.$ | 10. $n^3 - 18n + 45.$ |
| 3. $x^3 - 13x + 22.$ | 11. $x^3 - 16x + 28.$ |
| 4. $y^3 - 14y + 33.$ | 12. $36 - 15z + z^2.$ |
| 5. $z^3 - 12z + 11.$ | 13. $k^3 - 17k + 30.$ |
| 6. $a^3 - 13a + 40.$ | 14. $30 - 31b + b^2.$ |
| 7. $m^3 - 18m + 32.$ | 15. $s^3 - 16s + 55.$ |
| 8. $n^3 - 14n + 13.$ | 16. $y^3 - 16y + 63.$ |

- | | |
|-------------------------|--------------------------|
| 17. $48 - 14 c + c^2$. | 22. $80 + 18 y + y^2$. |
| 18. $z^2 - 27 z + 50$. | 23. $d^2 + 17 d + 72$. |
| 19. $w^2 + 20 w + 51$. | 24. $x^2 - 20 x + 99$. |
| 20. $50 + 15 t + t^2$. | 25. $99 - 100 a + a^2$. |
| 21. $h^2 + 17 h + 42$. | |

- 592.** 1. The product of $x + 5$ and $x - 3$ is $x^2 + 2x - 15$.
 2. The product of $x - 5$ and $x + 3$ is $x^2 - 2x - 15$.

What gives a minus sign in a product?

Why is the sign of the last term of the product minus in each of the above statements?

Note that in each of the products the coefficient of the second term is the *difference* between 5 and 3.

In the factors in the first statement, has the larger number a plus or a minus sign? What is the sign of the second term of the product?

In the factors in the second statement, has the larger number a plus or a minus sign? What is the sign of the second term of the product?

Factor $x^2 - 4x - 45$.

We must find two numbers whose product is 45 and whose difference is 4. We see that 9 and 5 are such numbers.

The sign of the second term in the given expression is minus, so we must give the minus sign to the larger of the two numbers which we have found.

$$x^2 - 4x - 45 = (x - 9)(x + 5).$$

In a similar manner, we would get

$$x^2 + 4x - 45 = (x + 9)(x - 5).$$

$$x^2 + x - 56 = (x + 8)(x - 7).$$

$$x^2 - x - 56 = (x - 8)(x + 7).$$

593. Factor:

- | | |
|----------------------|-----------------------|
| 1. $x^3 - x - 12.$ | 14. $x^2 - 5x - 36.$ |
| 2. $x^2 + x - 12.$ | 15. $a^2 - 5a - 14.$ |
| 3. $a^2 + 3a - 10.$ | 16. $b^2 - 7b - 30.$ |
| 4. $a^2 - 3a - 10.$ | 17. $z^2 - 2z - 35.$ |
| 5. $y^2 - 4y - 12.$ | 18. $m^2 + 4m - 60.$ |
| 6. $y^2 + 4y - 12.$ | 19. $k^2 + 3k - 54.$ |
| 7. $c^2 + 5c - 6.$ | 20. $x^2 + 2x - 48.$ |
| 8. $d^2 - 7d - 18.$ | 21. $t^2 - 10t - 11.$ |
| 9. $d^2 + 7d - 18.$ | 22. $y^2 + 7y - 60.$ |
| 10. $k^2 - 7k - 8.$ | 23. $h^2 - 9h - 36.$ |
| 11. $g^2 - 2g - 24.$ | 24. $a^2 - 2a - 120.$ |
| 12. $x^2 - 5x - 24.$ | 25. $d^2 + 5d - 150.$ |
| 13. $x^2 + 5x - 36.$ | 26. $d^2 - 5d - 150.$ |

594. If we divide $x^3 - y^3$ by $x - y$, the quotient is $x^2 + xy + y^2$.

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2).$$

The difference of the cubes of two quantities may be divided by the difference of the quantities. The quotient consists of three terms, namely : *the square of the first, plus the product of the first and second, plus the square of the second.*

$$(a^3 + b^3) \div (a + b) = a^2 - ab + b^2.$$

Give a general statement for the quotient obtained by dividing the sum of the cubes of two quantities by the sum of the quantities.

Factor $a^3 + 8.$

$$8 = 2^3,$$

hence

$$a^3 + 8 = a^3 + 2^3,$$

$$a^3 + 2^3 = (a + 2)(a^2 - 2a + 2^2),$$

since

$$2^2 = 4,$$

$$a^3 + 8 = (a + 2)(a^2 - 2a + 4).$$

595. Factor:

- | | | |
|---------------------|-----------------------|-------------------------|
| 1. $m^3 - x^3$. | 10. $m^3 + 8n^3$. | 18. $x^3 - y^6$. |
| 2. $m^3 + x^3$. | 11. $a^3b^3 + 8$. | 19. $r^3 + 27$. |
| 3. $a^3 + 1$. | 12. $8yz^3 + 1$. | 20. $a^3 - 64$. |
| 4. $a^3 - 1$. | 13. $(3x)^3 - y^3$. | 21. $a^3 + 64$. |
| 5. $1 - a^3$. | 14. $x^3 + (3)^3$. | 22. $x^3 - 64y^3$. |
| 6. $b^3 - c^3d^3$. | 15. $1 + 27d^3$. | 23. $a^3b^3 + c^3d^3$. |
| 7. $b^3c^3 + r^3$. | 16. $27a^3 - 1$. | 24. $64 - x^3$. |
| 8. $(2a)^3 - b^3$. | 17. $(a^2)^3 - b^3$. | 25. $a^3 - 125$. |
| 9. $8a^3 - c^3$. | | |

596. The following supplementary exercises are applications of the preceding cases. Sometimes it is possible to apply more than one case to an exercise.

1. Factor $2a^4x - 2a^3x^3 - 24x^5$.

First divide by $2x$.

$$2a^4x - 2a^3x^3 - 24x^5 = 2x(a^4 - a^3x^2 - 12x^4),$$

$$\text{but } a^4 - a^3x^2 - 12x^4 = (a^2 + 3x^2)(a^2 - 4x^2);$$

$$\text{hence } 2a^4x - 2a^3x^3 - 24x^5 = 2x(a^2 + 3x^2)(a^2 - 4x^2),$$

$$\text{but } a^2 - 4x^2 = (a + 2x)(a - 2x);$$

$$\text{hence } 2a^4x - 2a^3x^3 - 24x^5 = 2x(a^2 + 3x^2)(a + 2x)(a - 2x).$$

2. Factor $x^6 - y^6$.

Since $x^6 = (x^3)^2$, and $y^6 = (y^3)^2$,

$$x^6 - y^6 = (x^3 + y^3)(x^3 - y^3).$$

Factoring the second member of the above equation,

$$x^6 - y^6 = (x + y)(x^2 - xy + y^2)(x - y)(x^2 + xy + y^2).$$

When in doubt prove your work by either multiplication or division.

597. Factor:

1. $7a^3y + 21axy^2$.
2. $ab^2 - 2abc + ac^2$.
3. $a^2b + 3abc + 2bc^2$.
4. $a^3 + 2a^2 + a$.
5. $x^8 - 216$.
6. $a^2b^2c^2 + 6abc + 9$.
7. $3n^4 + 81n$.
8. $n^4 - 81n$.
9. $a^4 - a$.
10. $2a^2 - 2ab - 24b^2$.
11. $x^4 + 2x^2y^2 + y^4$.
12. $x^6 + 5x$.
13. $y^8 - 25y^3$.
14. $m^2 + 25mn + 100n^2$.
15. $a^2 - 20abc + 100b^2c^2$.
16. $x^2 - 16y^4$.
17. $a^4 - 16a^2b + 55b^2$.
18. $x^3 + x^2y^3$.
19. $x^4 + x^2y^2$.
20. $x^4 - x^2y^2$.
21. $xy^2 - xy - 6x$.
22. $x^2y - 5xy^2 + 6y^3$.
23. $a^3b^2 + 5a^2b^3 + 10ab^5$.
24. $(3m)^2 + 2(3m) + 1$.
25. $(x+y)^2 + 2(x+y) + 1$.
26. $(x+y)^3 - 2(x+y)z + z^2$.
27. $3b^6 - 5b^8$.
28. $(x+y)^3 - 1$.
29. $a^2 - 2ab + b^2 - 1$.
30. $z^2 - z^6$.
31. $125x + x^4$.
32. $x^4 - 5x^2 + 4$.
33. $a^4 - 2a^2 - 8$.
34. $100 + 25y^2$.
35. $100 - 25y^2$.
36. $ab^3 - 144ac^3$.
37. $12xy^2 - 144xz^2$.
38. $3x^2 - 9x - 84$.
39. $ax^2 - a + 2abx + ab^2$.
40. $x^4 + 2x^2 + 1 - a^2$.
41. $x^4 + 2x^2 + 1 - x^2$.
42. $a^4 + a^2 + 1$.
- (Change 42 to same form as
41.)
43. $y^8 - 13y + 36$.
44. $b^4 - 13b^2 + 36$.
45. $z^6 + z^3 + z$.
46. $m^4 - 16$.
47. $16 - m^4n^6$.
48. $16m + 2m^4$.
49. $16a - a^4$.
50. $a^6 - 64$.

FRACTIONS.

598. Preliminary Exercises.

1. Reduce $\frac{xy}{xz}$ to its lowest terms. *Ans.* $\frac{y}{z}$.

Divide the numerator and the denominator by x .

2. Change $\frac{a}{b}$ to an equivalent fraction whose denominator is bc . *Ans.* $\frac{ac}{bc}$.

Multiply the numerator and the denominator by c .

The value of a fraction is not changed when both numerator and denominator are either multiplied or divided by the same quantity.

599. Oral Exercises.

Reduce:

1. $\frac{2ax}{3x}$. 2. $\frac{2ab}{3a^3}$. 3. $\frac{7b^8x^3}{21b^8x^3}$. 4. $\frac{7a^3}{a^3}$.

5. $\frac{ax+ay}{3ab}$. 7. $\frac{2ab^4}{a+ab}$. 9. $\frac{nxy+x}{ax+x^3}$.

6. $\frac{12a^3b^3}{6ab}$. 8. $\frac{a^3+2ab}{3ab}$. 10. $\frac{2px+3xy}{px+xy}$.

600. Sight Exercises.

Give answers at sight:

1. $\frac{b}{3} = \frac{?}{3x}$. 6. $4a = \frac{16a^3}{?}$.

2. $\frac{2y}{3x} = \frac{?}{3x^3}$. 7. $\frac{y+z}{2a} = \frac{?}{2ab}$.

3. $\frac{2a}{3} = \frac{2ac}{?}$. 8. $2ab^3 = \frac{2ab^3}{?}$.

4. $\frac{5xy}{7m} = \frac{?}{14mn}$. 9. $3mt = \frac{?}{3mt}$.

5. $4a = \frac{?}{a}$. 10. $a+b = \frac{2a^3b+2ab^3}{?}$.

601. Written Exercises.

1. Reduce $\frac{x^2 + 11x + 30}{x + 5}$.

Divide the numerator by the denominator. *Ans.* $x + 6$.

2. Reduce $\frac{x^2 + 12x + 35}{x + 5}$.

3. Reduce $\frac{x^2 + 10x + 20}{x + 4}$. *Ans.* $x + 6 - \frac{4}{x + 4}$.

4. $b + c = \frac{?}{b + c}$. 5. $\frac{1}{c^2 + c + 5} = \frac{2c + 3}{?}$.

6. Change $x + 2$ to a fraction whose denominator is $x + 3$.

$x + 2 = \frac{x + 2}{1}$. Multiply the numerator and the denominator by $x + 3$.

7. $x - 3 = \frac{?}{x + 5}$. 8. $x^2 - x + 1 = \frac{?}{x + 1}$.

9. Change $x + \frac{x - 3}{x + 2}$ to a fraction.

$$x = \frac{x^2 + 2x}{x + 2}$$

$$\frac{x^2 + 2x}{x + 2} + \frac{x - 3}{x + 2} = \frac{?}{x + 2}.$$

What may be done with the numerators when the denominator is common?

10. Reduce $\frac{8x^3 - 1}{2x - 1}$. 13. $\frac{x}{x + 2} + \frac{3x}{x + 2} = ?$

11. $x - 1 - \frac{x - 3}{x + 2} = \frac{?}{x + 2}$. 14. $\frac{1}{x} = \frac{?}{2x^2 + x}$.

12. $\frac{3}{2x} + \frac{5}{x + 2} = \frac{?}{2x^2 + 4x}$. 15. $\frac{2}{y} = \frac{?}{y^2 - y}$.

16. $\frac{3}{x} + \frac{x - 3}{2x + 1} + \frac{x^2 - 5}{2x^2 + x} = \frac{?}{2x^2 + x}$.

17. $\left(\frac{x+1}{x-1}\right)\left(\frac{x+2}{x-2}\right) = ?$; i.e., $\frac{(x+1)(x+2)}{(x-1)(x-2)} = ?$

$\frac{1}{2}$ multiplied by $\frac{1}{2} = ?$

18. $\frac{x+1}{x-1} + \frac{x+2}{x-2} = ?$; i.e., $\frac{(x+1)(x-2)}{(x-1)(x+2)} = ?$

19. By what quantity must $x - 5$ be multiplied to give a product of $x^3 + x - 30$?

By what number must 7 be multiplied to give a product of 63?

20. $\frac{1}{x-5} = \frac{?}{x^3 + x - 30}.$

21. $\frac{a}{x-6} = \frac{?}{x^3 - x - 30}.$

22. $\frac{a}{x-1} = \frac{ax+a}{?}.$

23. $\left(\frac{x-2}{x-5}\right)\left(\frac{x+5}{x+2}\right) = ?$

24. $\frac{x+1}{x-1} = \frac{x^3 + 2x + 1}{?}.$

25. $\frac{x-5}{x+1} = \frac{?}{x^3 - 1}.$

26. $\frac{x-5}{x+3} + \frac{x-1}{x+4} = ?$

27. Add $\frac{x-5}{x+1}$ and $\frac{x-2}{x-1}$. *Ans.* $\frac{2x^3 - 7x + 3}{x^3 - 1}$.

28. $\frac{x-2}{x-1} - \frac{x-5}{x+1} = ?$

29. $\frac{x+5}{x-3} = \frac{?}{x^3 - x - 6}.$

30. $\frac{27a^3x^3 - 2}{3ax - 1} = ?$

PURE QUADRATICS.

602. Given $\frac{x^2 + 6}{5} = \frac{3x^2 - 66}{9}$, to find the value of x .

Clearing of fractions,

$$9x^2 + 54 = 15x^2 - 330.$$

Transposing and combining,

$$-6x^2 = -384.$$

Dividing by -6 ,

$$x^2 = 64.$$

Extracting square root,

$$x = \pm 8.$$

Since $(-8) \times (-8) = 64$, the square root of 64 may be either $+8$ or -8 . It is written ± 8 , and is read "*positive or negative 8.*" (It is sometimes less correctly called *plus or minus 8.*)

603. Written Exercises.

Find value of x , y , z , etc.:

1. $x^2 - 13 = 36$.

2. $3y^2 + 25 = 100$.

3. $5z^2 - 13 = 3z^2 + 37$.

4. $5(x^2 + 17) - 3x^2 + 63 = 198$.

5. $5(x^2 + 17) - 3(x^2 - 21) = 198$.

6. $y^2 + 2y + 1 - y^2 = 49$.

7. $(x + 1)^2 - x^2 = 49$.

8. $\frac{y^2 + 5}{3} - \frac{2y^2 - 18}{4} = 2$.

9. $\frac{z+7}{z-3} = \frac{z-5}{z-9}$.

10. $\frac{20x}{x-1} = \frac{30x}{x+1}$.

11. $(x - 3)(x + 3) = 40.$

12. $(x + 5)(x + 5) = 10x + 26.$

13. $(x + 4)^2 = 8x + 80.$

14. $x^2 + 64 = 5z^2.$

15. $3x^2 + 18 = 2\frac{1}{2}x^2 + 36.$

16. $(x - 3)^2 - (x - 5)^2 = 12.$

17. $(x + 7)(x - 9) = (x - 3)(x - 5).$

18. $\frac{x}{4} + \frac{4}{x} = \frac{x}{9} + \frac{9}{x}.$

19. $\frac{x+7}{x-5} = \frac{x-3}{x-9}.$

20. $\frac{y-9}{y-5} = \frac{y-3}{y+7}.$

604. Written Problems.

- Find the dimensions of a field, the length of which is twice its breadth, its area being 1800 square rods.
- The surface of the six equal faces of a cube contains 96 square inches. Find the length of one edge.
- One number is four-fifths of another, and their product is 80. What are the numbers?
- One-third of a number multiplied by two-fifths of the same number gives a product of 270. Find the number.
- Thirty per cent of a number multiplied by forty per cent of the same number gives a product of 300. What is the number?
- Thirty per cent of twenty per cent of a number is 300. What is the number?

7. The base of a right-angled triangle is $\frac{3}{4}$ as long as the perpendicular, and the area of the triangle is 96 square rods. Find the length of the base. What is the length of the hypotenuse?

8. The base of a right-angled triangle measures x yards, the perpendicular measures $\frac{3}{4}x$ yards. What is the length of the hypotenuse? If the hypotenuse measures 15 yards, find the length of the base.

9. The base of a right-angled triangle measures x feet, the hypotenuse measures $(x + 9)$ feet, the perpendicular measures 15 feet. What is the length of the base?

10. The difference between the squares of two consecutive numbers is 49. What are the numbers?

11. The difference between two numbers is 6. The sum of their squares is 146. What are the numbers?

Let $x - 3$ = smaller number,
and $x + 3$ = greater number.

AFFECTED QUADRATICS.

605. Preliminary Exercises.

$$(x + 1)(x + 1) = x^2 + 2x + 1.$$

Compare with Article 582.

$$(x - 1)(x - 1) = x^2 - 2x + 1.$$

Compare with Article 584.

$$(a + b)^2 = a^2 + 2ab + b^2.$$

$$(m - n)^2 = m^2 - 2mn + n^2.$$

$$(10 + 5)^2 = 10^2 + 2 \times 10 \times 5 + 5^2.$$

$$(10 - 3)^2 = 10^2 - 2 \times 10 \times 3 + 3^2.$$

606. Oral Exercises.

Square:

- | | | | |
|--------------|---------------|---------------|----------------|
| 1. $x + 3$. | 4. $x + 10$. | 7. $30 - 1$. | 10. $x - y$. |
| 2. $x - 7$. | 5. $a - b$. | 8. $40 - 1$. | 11. $80 + 5$ |
| 3. $x - 9$. | 6. $x + y$. | 9. $m + n$. | 12. $60 - 5$. |

607. Oral Exercises.

Extract the square root of

- | | |
|------------------------|-------------------------|
| 1. $x^2 + 6x + 9$. | 6. $x^2 + 2xy + y^2$. |
| 2. $x^2 - 14x + 49$. | 7. $x^2 - 2xy + y^2$. |
| 3. $x^2 - 18x + 81$. | 8. $a^2 - 2ab + b^2$. |
| 4. $x^2 + 20x + 100$. | 9. $x^2 - 24x + 144$. |
| 5. $a^2 + 2ab + b^2$. | 10. $x^2 + 22x + 121$. |

The square of $(x + 3)$ consists of how many terms? Of how many terms does $(x + 4)^2$ consist? $(x + 5)^2$?

608. Supply term necessary to make a complete square:

- | | |
|--------------------|---------------------|
| 1. $x^2 + 6x + ?$ | 6. $x^2 + 2x + ?$ |
| 2. $x^2 - 12x + ?$ | 7. $x^2 - 4x + ?$ |
| 3. $x^2 - 8x + ?$ | 8. $x^2 - 10x + ?$ |
| 4. $x^2 - 16x + ?$ | 9. $x^2 + 14x + ?$ |
| 5. $x^2 + 18x + ?$ | 10. $x^2 - 22x + ?$ |

609. Written Exercises.

Given $x^2 + 6x = 27$.

What number must be added to the first member of the equation to make it a "complete" square?

If a number is added to one member of an equation, what must be done to the other member to preserve the equality?

610. Extract the square root of both members of the following equations, adding to both, where necessary, such a number as will make the first member a complete square.

$$1. \quad x^2 + 6x + 9 = 40 + 9. \quad 2. \quad x^2 - 12x + 36 = 28 + 36.$$

Remember that $(+ 7) \times (+ 7) = 49$, and that $(- 7) \times (- 7) = 49$.
 $\therefore \sqrt{49} = + 7$ or $- 7$, written ± 7 .

$$3. \quad x^2 - 8x + 16 = 20 + 16. \quad 7. \quad x^2 - 14x = 15.$$

$$4. \quad x^2 - 16x + 64 = - 39 + 64. \quad 8. \quad x^2 - 22x = 23.$$

$$5. \quad x^2 + 18x + ? = 19 + ? \quad 9. \quad x^2 + 14x = 51.$$

$$6. \quad x^2 + 2x + ? = 24 + ? \quad 10. \quad x^2 - 22x = 48.$$

611. Given $x^2 - 10x = 24$.

Completing the square, we have $x^2 - 10x + 25 = 24 + 25 = 49$.
Extracting the square root of both sides, we have

$$x - 5 = \pm 7,$$

$$x = 7 + 5 = 12, \text{ or } x = - 7 + 5 = - 2.$$

Ans. 12 or $- 2$.

612. Written Exercises.

Find values of x :

- | | |
|------------------------|-------------------------|
| 1. $x^2 - 6x = 7.$ | 9. $x^2 - 24x = 0.$ |
| 2. $x^2 - 12x = 108.$ | 10. $x^2 - 8x = 384.$ |
| 3. $x^2 + 2x = 48.$ | 11. $x^2 - 4x = - 3.$ |
| 4. $x^2 + 18x = 115.$ | 12. $x^2 + 30x = 175.$ |
| 5. $x^2 - 14x = - 13.$ | 13. $x^2 + 28x = 29.$ |
| 6. $x^2 - 10x = 0.$ | 14. $x^2 + 22x = 104.$ |
| 7. $x^2 + 20x = 125.$ | 15. $x^2 - 16x = - 64.$ |
| 8. $x^2 + 26x = 56.$ | 16. $x^2 + 36x = 76.$ |

To make the first member a complete square, you added the square of what part of the coefficient of x ?

613. Written Exercises.

Find values of x :

- | | |
|--|------------------------|
| 1. $x^2 + x = 12,$ | 5. $x^2 + 9x = -20.$ |
| $x^2 + x + (\frac{1}{2})^2 = 12 + (\frac{1}{2})^2.$ | 6. $x^2 - 11x = -28.$ |
| 2. $x^2 - 3x = 10,$ | 7. $x^2 + 13x = -42.$ |
| $x^2 - 3x + (\frac{9}{4})^2 = 10 + (\frac{9}{4})^2.$ | 8. $x^2 - 15x = 76.$ |
| 3. $x^2 + 5x = -4.$ | 9. $x^2 - 17x = 18.$ |
| 4. $x^2 - 7x = 8.$ | 10. $x^2 + 19x = -18.$ |

614. When x^2 has a coefficient, divide both members by the coefficient.

$$3x^2 + 9x = 84.$$

Dividing by 3,

$$x^2 + 3x = 28.$$

Completing the square,

$$x^2 + 3x + (\frac{3}{2})^2 = 28 + \frac{9}{4} = \frac{112 + 9}{4} = \frac{121}{4}.$$

Extracting square root,

$$x + \frac{3}{2} = \pm \frac{11}{2}.$$

$$\therefore x = \frac{11}{2} - \frac{3}{2} = \frac{8}{2} = 4; \text{ or } -\frac{11}{2} - \frac{3}{2} = -\frac{14}{2} = -7.$$

Ans. 4 or -7.

615. Written Exercises.

- | | |
|------------------------|-------------------------|
| 1. $6x^2 - 6x = 36.$ | 6. $3x^2 + 9x = 54.$ |
| 2. $9x^2 + 9x = 180.$ | 7. $8x^2 - 72x = -160.$ |
| 3. $7x^2 + 28x = 147.$ | 8. $7x^2 + 49x = 56.$ |
| 4. $4x^2 - 40x = -64.$ | 9. $3x^2 + 21x = 54.$ |
| 5. $8x^2 - 16x = 504.$ | 10. $5x^2 - 25x = -20.$ |

616. Five times nothing = ?

Zero multiplied by one million = ?

If

$$x = 5,$$

$$x - 5 = ?$$

$$10(x - 5) = ?$$

$$(x + 5)(x - 5) = ?$$

If one of two factors is zero, the product is zero.

The converse is also true.

If the product of two factors is zero, one of the factors is zero.

Given $(x - 2)(x - 3) = 0$.

One of the factors in the above equation is equal to zero.

If $x - 2 = 0$,

by transposing we get $x = 2$.

If $x - 3 = 0$,

$$x = 3.$$

617. A quadratic equation may sometimes be readily solved by factoring.

$$1. \quad x^2 - 5x = -6. \quad 2. \quad x^2 - 5x = 14.$$

$$x^2 - 5x + 6 = 0. \quad x^2 - 5x - 14 = 0.$$

$$(x - 3)(x - 2) = 0. \quad (x - 7)(x + 2) = 0.$$

$$x = 3 \text{ or } 2. \quad x = 7 \text{ or } -2.$$

Solve by factoring:

$$3. \quad x^2 + x - 6 = 0. \quad 8. \quad z^2 - 4z + 7 = 19.$$

$$4. \quad x^2 + 2x - 3 = 0. \quad 9. \quad y^2 + 10 = 28 + 3y.$$

$$5. \quad x^2 - 3x + 2 = 12. \quad 10. \quad x^2 - 2x - 24 = 0.$$

$$6. \quad y^2 + 7y + 15 = 3. \quad 11. \quad x^2 - 15x = 16.$$

$$7. \quad x^2 - 7x + 20 = 8. \quad 12. \quad y^2 + 19y = 20.$$

618. Written Problems.

1. The sum of two numbers is 12; their product is 32.
What are the numbers?

x and $12 - x$ = numbers. $(12 - x)x$ = product.

2. The base of a rectangle is 50 feet longer than its altitude. x
Its area is 2400 square feet. How long is the base?

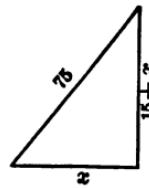
$$\boxed{\text{Area } x^2 + 50x}$$

$$2400 \text{ sq. ft.}$$

$$x + 50$$

3. The perpendicular of a right-angled triangle measures 15 yards more than the base. The hypotenuse is 75 yards. Find the length of the perpendicular.

$$x^2 + (15 + x)^2 = 75^2.$$



4. The hypotenuse of a right-angled triangle is $1\frac{1}{4}$ times as long as the base. The area of the triangle is 150 square yards. How long is the hypotenuse?

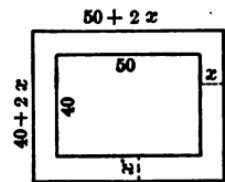
$$\text{Perpendicular} = \sqrt{(\frac{1}{4}x)^2 - x^2}; \text{area} = \frac{1}{2} \text{base} \times \text{perpendicular}.$$



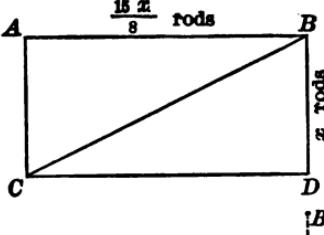
5. The entire surface of a square prism is 170 square feet. Its altitude is 6 feet, and one side of its base is x feet. Find the value of x .

6. A garden 50 feet long, 40 feet wide, has a walk just outside it x feet wide. Find the area of the walk.

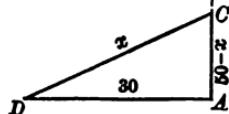
If the area of the walk is 784 square feet, what is its width?



7. A field, $ABCD$, contains 12 acres. Its length is $1\frac{1}{8}$ times its breadth. How many rods long is the diagonal BC ?



8. A flag-staff, AB , 50 feet high, was broken off at the point C . The broken part, resting on C , reached the ground D , 30 feet from the base of the staff. Find the length of the part broken off.



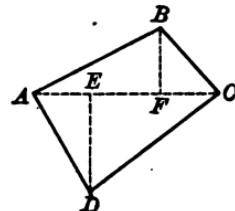
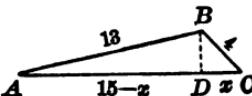
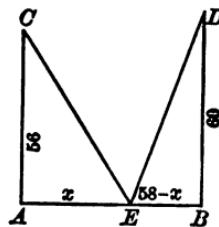
9. A ladder, CE or DE , placed at a point E , in a street 58 feet wide between the opposite houses, just touches the top of a house, DB , 60 feet high on one side of the street, or the top of a house, CA , 56 feet high on the other side. Find the length of the ladder.

$$\overline{DE}^2 = 60^2 + (58 - x)^2 = \overline{CE}^2 = 56^2 + x^2.$$

10. ABC is a triangle. The side AB measures 13 feet; the side BC , 4 feet; AC , 15 feet. Find the altitude BD .

$$\overline{BD}^2 = \overline{AB}^2 - \overline{AD}^2 = \overline{BC}^2 - \overline{CD}^2.$$

11. $ABCD$ is a trapezium. $AB = 34$ feet; $BC = 20$ feet; $CD = 40$ feet; $DA = 26$ feet. The perpendicular BF measures 16 feet. Find the length of the diagonal AC and of the perpendicular ED .



CHAPTER VIII.

GEOOMETRY.

619. Vertical Lines.

Hang a weight from a fixed point by a string. When the weight stops swinging the string is in a *vertical* line. What way does the lower end of the string point? the higher end? Hold a sheet of ruled paper so that the lines are vertical.

620. Oblique and Horizontal Lines.

Hold a pointer so that it points upward but not straight up. It is in an *oblique* line.

Hold a pointer so that it does not point or slant either up or down. It is in a *horizontal* line.

Note. — In representing vertical, horizontal, or oblique lines on the page of a book or a sheet of paper it is assumed that the book or paper is held in an upright position.

621. Oral Exercises.

1. What kind of line is represented by the course of a drop of water running down a roof?

2. By the course of a falling raindrop when there is no wind?

3. By the course of a falling raindrop when there is a wind?

4. By straws floating on the surface of still water?

Use the object for the four following exercises.

5. How many lines are there in the edges of a cube or a rectangular box?

6. When the cube is placed on a level table, how many edges are vertical? How many are horizontal? How many are oblique?
7. Hold the cube so that four edges are horizontal. How many are vertical? How many are oblique?
8. Hold the cube so that no edges are horizontal. How many are oblique? How many are vertical?
9. A straight line is 3 feet long. What kind of line is it if one end is 4 feet from the floor and the other end is 1 foot from the floor?
10. If one end of a 3-foot straight line is 4 feet from the floor and the other end is 2 feet from the floor, what kind of line is it?
11. If each end of a straight line is 5 feet from the floor, what kind of line is it?
12. If one end of a straight line is 4 feet from the floor and the middle is 4 feet from the floor, what kind of line is it?
13. A vertical straight line is 5 feet long. The middle is 5 feet from the floor. How far is each end from the floor?
14. A vertical line is 4 feet long. One end is 5 feet from the floor. How far from the floor is the other end? Why are there two answers?

622. Angles.

When the ends of two straight lines meet they form an angle.

What two lines form the angle ABC in the above figure?

At what point do they meet?

The point B is the vertex of the angle ABC .

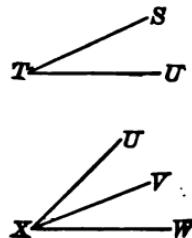
What is the vertex of an angle?



623. Designation of Angles.

The angle formed by the lines ST and TU may be called the angle T . It is frequently better to call it the angle STU or UTS , the letter at the vertex being placed between the two others.

The use of the three letters is necessary where two or more angles have vertices at the same point, as in the accompanying figure, where UX , VX , and WX meet at the point X .

**624. Exercises.**

Draw a horizontal line 3 inches long. Mark a point in this line one inch from the left end. From this point draw a line upward slanting towards the right. Mark each end of each line by a letter. How many angles have you formed? Designate each of these angles by three letters.

NOTE. — The above exercise may be varied for blackboard drill—draw a vertical line 11 inches long; mark a point 4 inches from the top; draw a line to the left slanting downward, etc.

How many angles are formed when two lines meet at their ends? When two lines pass *through* the same point? When from a point in one line another line is drawn?

625. Circular Measure.

60 seconds (")	1 minute.
60 minutes (')	1 degree.
360 degrees (°)	1 circle, or circumference.

626. Exercises.

1. What part of a circumference is 180° ? 90° ? 60° ? 30° ? 45° ? 36° ? 72° ?

2. 1° on the circumference of a circle is 5 inches. What is the length of the circumference?

3. The circumference of a circle is 9000 feet. $1^\circ = ?$
 $1' = ?$

4. How many degrees are there between the XII and the I on the face of a clock? between the XII and VI? between the XII and III? between the III and VII?

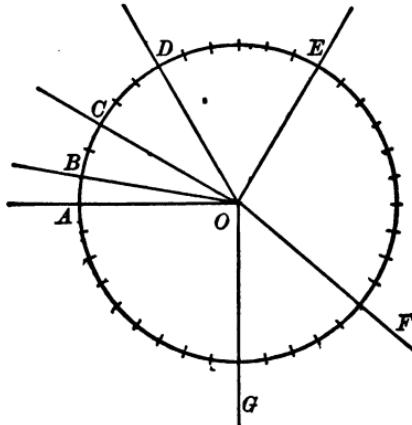
5. If one degree of the earth's circumference is $69\frac{1}{3}$ miles, find the circumference.

6. Through how many degrees does the minute hand of a clock pass in 1 hour? in $\frac{1}{2}$ hour? in 15 minutes? in 5 minutes? in 10 minutes? in 1 minute? in 3 minutes?

627. Angular Measure.

The angle at the centre of a circle has the same number of degrees as the arc between the sides of the angle.

Thus, in the following figure the angle AOC has the same number of degrees as the arc ABC .

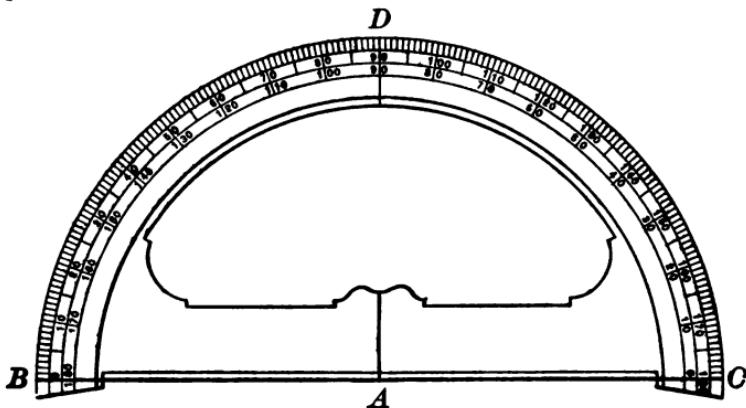


The circumference of this circle is divided into 36 equal parts. How many degrees are there in each part? How many degrees are there in each of the following angles?

$AOB, BOC, COD, DOE, EOF, FOG, GOA, AOE, DOF.$

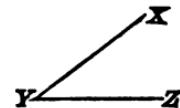
628. The Protractor.

The number of degrees in an angle may be measured by a protractor.

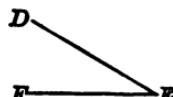


SEMICIRCULAR PROTRACTOR

To measure an angle, XYZ , for instance, produce the lines YX and YZ . Place the point A of the protractor on the vertex (Y) of the angle, and the edge AC on the line YZ produced. Using the lower line of figures, read off from the protractor the number of degrees at the point where the line YX produced cuts the semicircle.



In measuring the angle DEF , the line AB is placed on EF , the point A on the vertex E . The number of degrees in this case is read from the upper row of figures.



Note. — There is only one point on the protractor where the numbers of the upper and lower lines of figures are equal. What is the number of degrees at that point? What kind of angle is measured at that point? If an angle is acute, would you read its measure by the larger or by the smaller number?

EXERCISES IN CONSTRUCTION.

629. Note. — In the following exercises, the ruler, the compasses, and the protractor may be used.

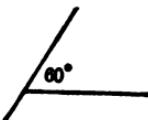
The drawing should be carefully done with a sharp, hard pencil.

1. Draw an obtuse angle formed by two lines, each one inch long. Draw an acute angle formed by two lines, each six inches long. Which is the larger?

2. The lines GH and IJ intersect at K , making four right angles. Which arc is longer, 78 or cd ? Which contains the greater number of degrees?

3. Draw two lines meeting at an angle of 45° . Two lines meeting at an angle of 90° . Two meeting at an angle of 135° .

4. Draw two lines making two angles, one of which measures 60° . How many degrees does the other angle contain?



5. To a horizontal line draw a line making two equal adjacent angles. How many degrees does each angle contain?

Two angles are said to be adjacent when they have one side in common.

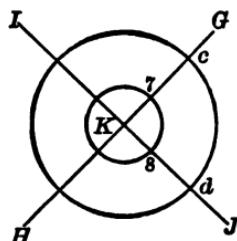
To a vertical line draw a line making two equal adjacent angles. How many degrees does each angle contain?

To an oblique line draw a line making two equal adjacent angles. How many degrees does each angle contain?

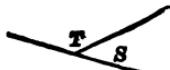
6. How many degrees are there in a right angle?

7. To an oblique line draw a line making two unequal adjacent angles. How many degrees are there in the sum of the two angles?

Two angles are said to be *supplementary* when they are together equal to two right angles.



8. How many degrees in the angle T , if S contains 75° ?



V measures 110° . How many degrees does U measure?



If one of two supplementary angles measures $63\frac{3}{4}^\circ$, how many degrees are there in the other angle?

How many degrees are there in an angle supplementary to one of $47^\circ 45'$?

9. Construct angle 5, 60° ; angle 4, 50° .
Measure angle 3.



How many degrees and minutes will there be in angle 5 when 3 contains $49\frac{1}{4}^\circ$ and 4 contains $83\frac{3}{4}^\circ$?

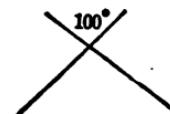
When angle 3 contains $36^\circ 30'$ and angle 5 contains $79^\circ 45'$, how many degrees and minutes will angle 4 contain?

10. Erect a perpendicular at each extremity of a horizontal line. At each extremity of a vertical line. At each extremity of an oblique line.

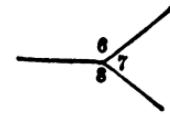
NOTE.—A line making a right angle with another line is said to be *perpendicular* to it.

11. Construct a square upon a horizontal line. Upon an oblique line.

12. Draw two lines intersecting at an angle of 100° . Mark in each of the other three angles the number of degrees it contains.



13. Draw two lines making an angle (6) of 150° . Construct an adjacent angle (7) containing 80° . How many degrees will angle 8 contain?



14. How many degrees will there be in the sum of five angles having the same vertex?



15. Draw five equal angles having a common vertex.
16. Draw six equal angles having a common vertex. Is any angle supplementary to the angle next it? Why? Are any of the angles vertical? Why?
17. Draw two angles, one of 65° and the other of 25° . Draw a third angle equal to the sum of both. Draw an angle equal to their difference.
18. Draw an angle equal to the sum of three angles measuring, respectively, 40° , 50° , and 60° .

630. Parallels.

Lines which lie in the same plane and which cannot meet, no matter how far produced, are said to be *parallel*.

19. Using the protractor, draw two or more lines that shall be perpendicular to a horizontal line. Where will they meet?

Draw two or more that shall be perpendicular to a vertical line. Where will they meet?

Draw two or more that shall be perpendicular to an oblique line. Where will they meet?

20. To a horizontal line draw two or more lines running in the same direction, and each making an angle of 35° with the first line. Will the oblique lines meet?

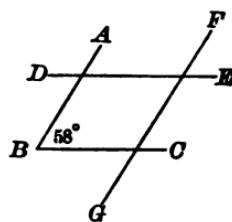
Draw two or more lines running in the same direction, and each making an angle of 125° with a vertical line. Will the oblique lines meet if produced very far?

Draw two or more lines running in the same direction, and each making an angle of 74° with an oblique line. Will the former lines meet?

21. Draw two lines making angles of 30° and 60° , respectively, with a third line. Will the two former lines meet if produced in either direction?

22. Draw a line, AB , meeting a horizontal line, BC , at an angle of 58° . Draw a third line, DE , parallel to the horizontal line, and cutting the oblique line. What angles does it make with the oblique line?

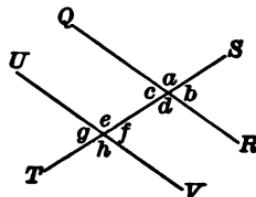
Draw a fourth line, FG , parallel to the oblique line, and cutting both horizontal lines.



Mark in each of the twelve angles the number of degrees it contains.

23. QR and UV are parallel lines, cut by a line ST . If the angle b measures 50° , how many degrees does a measure?

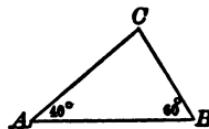
Find the number of degrees in each of the other six angles.



631. Triangles.

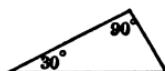
24. From the extremities of the line AB , draw lines that shall make angles of 60° and 40° , respectively, with AB . Prolong the lines until they meet at C , forming a triangle.

Measure the angle at C . How many degrees does it contain? How many degrees are there in the sum of the three angles of the triangle?

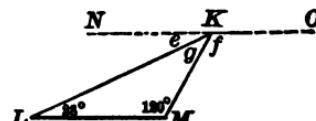


25. Construct a triangle having one angle of 90° and one of 30° . Measure the third angle.

How many degrees are there in the sum of the three angles?



26. Construct a triangle, KLM , making the angles at the base 28° and 120° , respectively. Draw NO , parallel to LM .



Is the angle e equal to any angle of the triangle? How many degrees does it contain? Is the angle f equal to any angle of the triangle? How many degrees does it contain?

How many degrees are there in the sum of the angles e, g , and f ? How many degrees are there in the angle g ?

27. How many degrees are there in the three angles of any triangle?

28. Two angles of a triangle measure 36° and 65° , respectively. How many degrees does the third angle contain?

29. Draw a triangle containing two angles of 50° and 70° , respectively. How many degrees are there in the third angle?

Measure each side, and mark on the side its length.

Opposite which angle is found the longest side? Opposite which, the shortest side?

30. Draw a triangle having two angles of 75° each. Are any two of its sides equal?

Draw a triangle having two angles of 50° each. Are any of its sides equal?

31. Draw a triangle having two angles of 60° each. How many degrees does the third angle contain?

Are any of its sides equal?

32. If a triangle has two of its sides equal, what is true of its angles?

33. If a triangle has three of its sides equal, what is true of its angles?

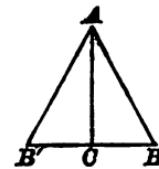
632. A triangle having all its sides equal, is called an *equilateral* triangle.

A triangle having two equal sides, is called an *isosceles* triangle.

A triangle having all its sides unequal, is called a *scalene* triangle.

34. How does a perpendicular let fall upon the base of an isosceles triangle from the opposite angle divide the angle? How does it divide the base? How do the angles at the base of an isosceles triangle compare with each other as to size?

The *unequal* side of an isosceles triangle is called the base.



35. Draw an isosceles triangle having the base a vertical line.

An isosceles triangle having the vertex below the base.

One having an oblique line for the base.

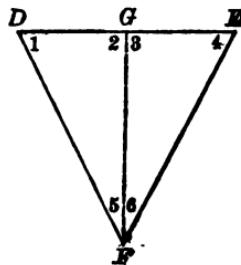
36. Draw a right-angled isosceles triangle. How many degrees will there be in each of the other angles?

Draw an obtuse-angled isosceles triangle.

37. How many degrees will there be in each angle of an equilateral triangle?

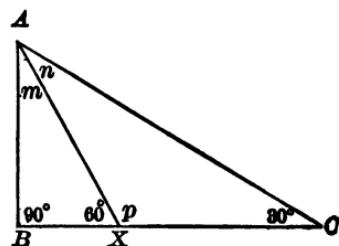
Draw an equilateral triangle having one side vertical.

Draw an equilateral triangle having its vertex below the base.



38. DEF is an isosceles triangle, DF and EF being the equal sides. If the angle 1 measures 50° , how many degrees are there in each of the other five angles, when the line FG bisects the base?

39. ABC is a right-angled triangle, the angle at B measuring 90° , and the angle at C measuring 30° . If the line AX is so drawn as to make the angle AXB equal to 60° , find the number of degrees in the angles m , n , and p , respectively.



633. Quadrilaterals.

A plane figure of four sides is called a *quadrilateral*.

When the opposite sides are parallel, the quadrilateral is called a *parallelogram*. (Figs. 1 to 8.)

A *rectangle* is a parallelogram all of whose angles are right angles. (Figs. 1 to 4.)

When the four sides of a rectangle are equal to each other, it is called a *square*. (Figs. 1 and 2.)

The term *oblong* is frequently applied to rectangles whose adjacent sides are unequal. (Figs. 3 and 4.)



FIG. 1.

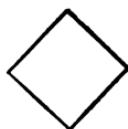


FIG. 2.

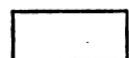


FIG. 3.



FIG. 4.

A *rhombus* is a parallelogram all of whose sides are equal, but whose angles are oblique. (Figs. 5 and 6.)

When the adjacent sides of a parallelogram are unequal and the angles are oblique, it is called a *rhomboid*. (Figs. 7 and 8.)



FIG. 5.

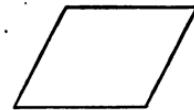


FIG. 6.



FIG. 7.



FIG. 8.

A *trapezoid* is a quadrilateral having only two of its sides parallel. (Figs. 9 and 10.)

A *trapezium* is a quadrilateral having no two sides parallel. (Figs. 11 and 12.)

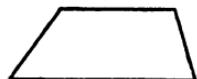


FIG. 9.



FIG. 10.



FIG. 11.

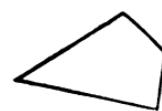
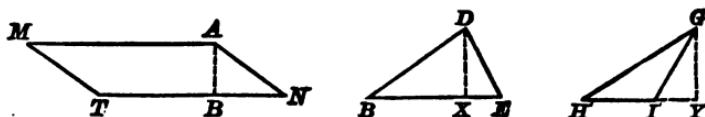


FIG. 12.

634. The *altitude* of a *parallelogram* is the perpendicular distance between its base and the side opposite.



The *altitude* of a *triangle* is the perpendicular distance between the vertex and the base, or between the vertex and base produced.

AB is the altitude of *MANT*; *DX* is the altitude of *DBE*; *GY* of *GHI*.

40. Draw a parallelogram. How many angles does it contain? Into how few triangles can you divide a parallelogram? How many degrees are there in the sum of the angles of each triangle? How many degrees are there in the sum of the angles of a parallelogram?

41. Construct a parallelogram, the adjacent sides of which shall measure 2 inches and 3 inches, respectively, and the angle between them 60° . How long will each of the other two sides be? Measure each of the other angles. How many degrees are there in the sum of the four angles?

42. Construct a trapezoid having a base of 5 inches, altitude 3 inches, the angles at the base measuring 90° and 60° , respectively. Measure the remaining angles, and find the sum of the four angles. How long is each of the remaining sides?

43. Fold a piece of paper twice at right angles, and cut off the folded corner, making a rhombus when the part cut off is opened out.

Can you cut out a rhombus having two angles of 60° each? A rhombus having two angles of 80° each?

44. Can you so cut a piece of paper, folded twice at right angles, that the part cut off will be a square?

45. Draw a rectangle, base $2\frac{1}{2}$ inches, altitude 2 inches.

A rhomboid, base $2\frac{1}{2}$ inches, altitude 2 inches.

46. Make, out of paper, a rectangle and a rhomboid, each having the above dimensions, and endeavor to ascertain, by cutting, whether or not they are equal to each other in area.

635. The Circle.

47. Draw a circle. Between two points on the circumference draw a line that does not pass through the centre.

This line is called a *chord*.

48. Draw a circle. In it draw two diameters, a radius, and three chords. Write on each line its name.

49. Draw a part of the circumference of a circle greater than one-half of it. Draw the chord.

A part of the circumference is called an *arc*.

50. Draw an arc less than a semi-circumference. Draw a chord. Write the name on each.

Can you make a chord that will be longer than the diameter?

51. Draw two equal circles. In the first draw the chord of an arc of 120° . In the second, the chord of an arc of 240° . What is the ratio between the two chords you have drawn?

52. In a circle draw a chord equal in length to the radius. How many degrees are there in the arc whose chord has been drawn?

53. Draw an arc of 72° . To its extremities draw two radii.

The part of the surface of a circle enclosed by two radii and the intercepted arc is called a *sector*.

54. Draw a sector of 60° (a *sextant*). A sector of 90° (a *quadrant*).

55. Draw an arc of 120° . Draw the chord.

The part of the surface of a circle bounded by an arc and its chord is called a *segment*.

56. Draw several circles having the same centre, but of unequal radii (*concentric circles*).

57. Draw two equal circles just touching each other (*tangent*). Draw two unequal circles tangent to each other.

Within a large circle draw a smaller one tangent to it.

58. Draw circles of equal radii cutting each other. Draw intersecting circles of unequal radii.

636. Pentagons, Hexagons, Octagons.

59. Divide the circumference of a circle into four equal arcs. Draw the chords, forming an inscribed square.

60. If you wish to inscribe in a circle a figure of five equal sides, into how many equal arcs must the circumference be divided? How many degrees will each arc contain?



637. A plane figure bounded by straight lines is called a *polygon*.

A five-sided polygon is called a *pentagon*; one of six sides, a *hexagon*; of seven, a *heptagon*; of eight, an *octagon*; of nine, a *nonagon*; of ten, a *decagon*; etc.

A *regular polygon* is one that is both equilateral and equiangular.

61. Inscribe a regular pentagon in a circle. Use the protractor.

62. Inscribe in a circle a regular hexagon. A regular octagon. An equilateral triangle.

- 63.** Inscribe in a circle a regular hexagon. Connect the opposite corners by lines passing through the centre of the circle, forming six triangles.

How many degrees are there in each of the six angles about the centre of the circle? In each of the twelve angles at the circumference?

How many degrees are there in the sum of angles 1 and 2?

Is each of the six triangles scalene, equilateral, or isosceles?

- 64.** Divide a regular inscribed pentagon into five equal triangles by lines drawn from the centre of the circle.

What kind of triangles are formed; isosceles, scalene, or equilateral?

How many degrees are there in each angle at the centre? In each angle at the circumference? How many degrees are there in the sum of two adjoining angles at the circumference? In each angle of the pentagon?

- 65.** About a circle circumscribe a square. An equilateral triangle. A regular pentagon. A regular hexagon. A regular octagon.

PROBLEMS IN CONSTRUCTION.

- 638.** In drawing the following exercises, only the ruler and the compasses are to be used. Use neither the protractor nor the triangle.

- 66.** Draw a circle, radius an inch and a half. Outside of it, and tangent to it, draw a second circle of an inch radius.

How far apart are the centres?

- 67.** Draw two tangent circles having radii of an inch and a half and an inch, respectively, one within the other.

How long is the line joining the centres?

- 68.** With centres 3 inches apart draw two equal circles tangent to each other. How long is the radius of each?



69. With centres three inches apart draw two equal circles of 2 inches' radius. Connect the centres.

Draw a line joining the two points in which the circles intersect. How does this line divide the line connecting the centres?

Draw radii from each centre to each point of intersection.

70. Construct an isosceles triangle, base 3 inches, equal sides 2 inches.

NOTE.—Use circles or arcs where necessary.

71. Construct an isosceles triangle, base $3\frac{1}{2}$ inches, equal sides 4 inches.

Divide it into two equal parts. Do not locate the centre of the base by measurements.

72. On a vertical line construct an isosceles triangle. Without measuring the length of the base draw a perpendicular to the centre of the base.

73. Bisect a vertical line. An oblique line.

Do not measure the length of the line.

74. Construct an equilateral triangle on a two-inch line.

75. Construct an equilateral triangle on a vertical line. On an oblique line.

76. Cut out two equal right-angled triangles. Put them together in different ways so as to form two different isosceles triangles.

77. Construct a scalene triangle.

A triangle having sides measuring 1, $1\frac{1}{2}$, 2 inches, respectively.

One whose sides measure 2, $2\frac{1}{2}$, and 3 inches, respectively.

78. Can you construct an isosceles triangle whose base measures 4 inches, equal sides 2 inches?

Try to construct a scalene triangle with sides measuring 1, 2, and 3 inches, respectively.

79. Draw a circle. In it draw a chord.
Bisect the chord, using as few lines and as short ones as you can.

NOTE.—Do not use the ruler to ascertain the length of the chord before bisecting it.

80. Divide a sector into two equal parts.
81. Draw a circle. Draw a chord. Draw a radius through the centre of the chord.

Is the radius perpendicular to the chord? Why?

82. Bisect the arc of a circle and its chord.
Bisect the arc of a circle without drawing the chord.
83. Draw a perpendicular to the middle point of a horizontal line. To the middle point of a vertical line. To the middle point of an oblique line.

84. Draw in a circle two diameters perpendicular to each other.

85. Divide the circumference of a circle into four equal parts. Into eight equal parts.

Inscribe a square in a circle.

86. Inscribe a regular octagon in a circle.

87. Connect the opposite vertices of a regular octagon inscribed in a circle by lines passing through the centre of the circle.

Lines connecting the opposite vertices of a polygon are called *diagonals*.

88. Inscribe a square in a circle. Circumscribe a square whose sides shall be perpendicular to the diagonals of the inscribed square.

89. Cut out the circumscribed square and show by folding that it is twice the area of the inscribed square.

90. Construct an equilateral triangle on a horizontal line 1 inch long. On the right side as a base, construct a second equilateral triangle. On the left side of the first triangle, construct a third. Construct three more, completing the hexagon.

91. Can you circumscribe a circle about the above hexagon? What is the radius of the circle?

92. Inscribe a regular hexagon in a circle whose radius is $1\frac{1}{2}$ inch. What is the length of each side of the hexagon?

93. Inscribe in a circle an equilateral triangle. On each of its three sides construct an equilateral triangle.

94. Construct an arc of 60° . Draw two lines meeting at an angle of 60° .

95. Bisect an arc of 60° . Draw two lines meeting at an angle of 30° .

96. Construct an angle of 60° and an angle of 30° . Draw two lines making an angle equal to the sum of the two angles first constructed.

97. Erect a perpendicular at the end of a horizontal line. At the end of a vertical line. At the end of an oblique line.

98. Construct an angle of 45° . An angle of $22\frac{1}{2}^\circ$. An angle of 135° . An angle of 15° . An angle of 75° .

99. Draw a circle, radius 1 inch. Draw a diameter, and produce it an inch beyond the circumference. At the centre of the circle erect a perpendicular to the diameter.

100. An inch from one end of a 3-inch line, erect a perpendicular, using as few and as short lines as possible.

101. Draw a horizontal line. Take a point above the line as a center. Draw an arc that cuts the line in two places.

102. Draw a line. From a point above the line, let fall a perpendicular to the line.

EQUAL TRIANGLES. EQUIVALENT TRIANGLES.

639. Note.—The protractor and the triangle may be used in the following exercises.

1. Draw a rectangle, base $2\frac{1}{2}$ inches, altitude 2 inches. Draw a rhomboid, base $2\frac{1}{2}$ inches, altitude 2 inches. Find the area of each.

2. With a base $2\frac{1}{2}$ inches, altitude 2 inches, draw
- (a) A right-angled triangle.
 - (b) An isosceles triangle.
 - (c) One or more acute-angled scalene triangles.
 - (d) One or more obtuse-angled triangles.

Calculate the area of each.

3. Can you show, by cutting from paper, that a right-angled triangle having its base and perpendicular 4 inches and 3 inches, respectively, has the same surface as an acute-angled triangle whose base and altitude are 4 inches and 3 inches respectively, and an obtuse-angled triangle whose base and altitude are 4 inches and 3 inches, respectively?

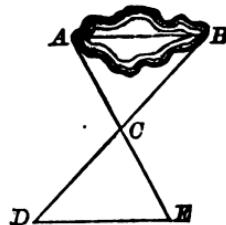
Two triangles that have the same area are called *equivalent* triangles; those having their corresponding sides and angles equal, each to each, are called *equal* triangles.

4. Construct a triangle whose sides measure $1\frac{1}{2}$, 2, and $2\frac{1}{2}$ inches, respectively. Construct another triangle having its sides of the same lengths. Are the angles of the second equal to the angles of the first? Are the triangles equal?

5. Draw two triangles each of which has two sides measuring $1\frac{1}{2}$ and 3 inches, respectively, and the included angle 60 degrees. Is the third side of one triangle equal to the third side of the other? Are the remaining angles of the first triangle equal to the remaining angles of the second?

6. Construct two triangles with equal bases, and angles at the bases respectively equal. Are the triangles equal?

7. A person wishing to ascertain the length, AB , of a pond, places a pole at a convenient point, C , visible from A and B . The distance BC is measured, and a pole is set up, on a line with B and C , at D , the distance CD being made equal to BC . A pole is also placed at E , on a line with A and C , the distance CE being made equal to AC .

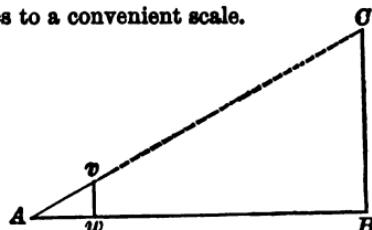


Can you show that the length, AB , of the pond can be ascertained by measuring the distance DE ?

CALCULATING HEIGHTS AND DISTANCES.

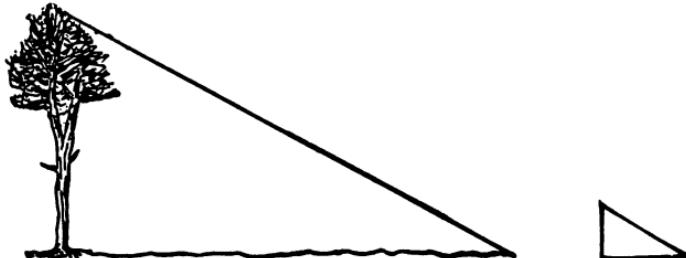
640. To verify the results obtained by calculation, the pupil should make diagrams, drawing the figures to a convenient scale.

1. If AB in a right-angled triangle measures 120 feet, and a perpendicular, wv , erected 10 feet from A measures 5 feet, calculate the length of BC .

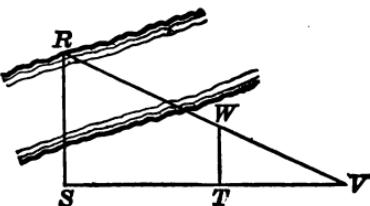


$$Aw : AB :: wv : BC; \text{ i.e. } 10 : 120 :: 5 : BC.$$

2. A post 6 feet above ground throws a shadow of $7\frac{1}{2}$ feet. How high is a tree whose shadow measures 60 feet?

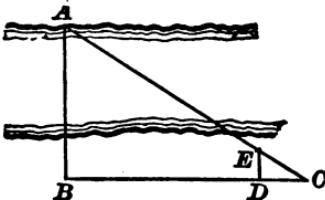


3. Wishing to ascertain the distance between two houses, R and S , on opposite sides of a stream, I measure a line, SV , at right angles to SR , 200 feet. At T , 90 feet from V , the perpendicular TW measures 60 feet. Required the distance SR .



$$VT : TW :: VS : SR$$

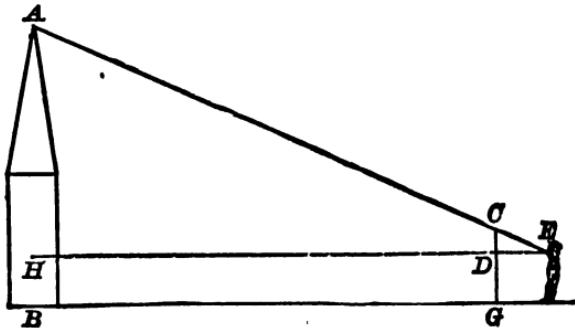
4. Beginning at B , 100 feet from the bank of a river, a line, BC , is measured 1200 feet long. At D , distant from C 50 feet, the perpendicular DE is found to measure 90 feet. What is the distance from B to A , a tree on the opposite bank? How wide is the river?



5. A boy, whose eye (E) is 4 feet from the ground, can just see the top (A) of a steeple when he stands back 3 feet from a fence (CG) 6 feet high. The distance from the foot of the fence to the centre of the base of the steeple is 177 feet. Find the height of the steeple, AB .

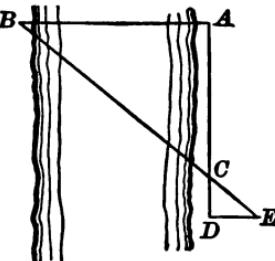
$$CD = ? \quad EH = ? \quad ED : CD :: EH : AH.$$

When AH is found, how may you get AB ?

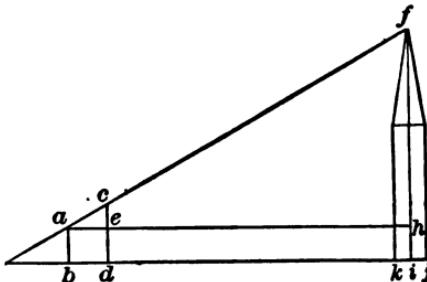


6. Wishing to ascertain the distance AB , I measure a line, AD , at right angles to AB , 12 chains; DE , at right angles to AD , 5 chains; and find that a line sighted from E to B intersects AD at C , distant from D 3.25 chains. What is the distance from A to B ?

NOTE.—The triangles DCE and ACB are similar. Why?



7. Wishing to find the height of a tower, fj , I set up a pole, cd , 12 feet long above the ground. Another pole, ab , $4\frac{1}{2}$ feet above ground, is set up at such a distance that the tops of the two poles and of the tower are in a line. The distance between the poles (ae or db) is $10\frac{1}{2}$ feet. The distance from d to the foot of the tower is 195 feet. The width of the tower (kj) is 30 feet.

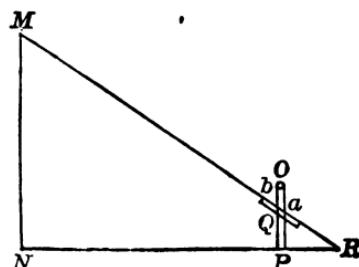


The similar triangles aec and ahf give us the proportion

$$ae : ah :: ec : hf.$$

What is the distance ec ? $ah = bi = bd + dk + ki$. $ki = \frac{1}{2}kj$. When fh is found, what must be added to get the height of the tower?

8. To determine the height of a building, MN , a person attached a straight strip of wood, ab , to a post, OP , in such a manner that sighting from a , he could just see M ,

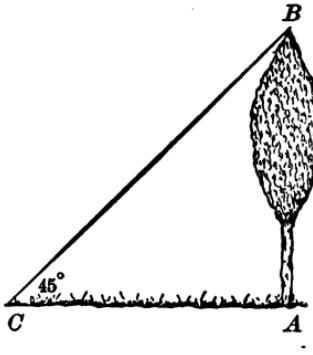


the top of the building. He then sighted down from b , and marked on the ground the point R , on a line with ab .

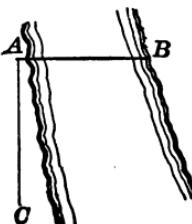
PQ was found by measurement to be 4 feet, RP 6 feet, PN 120 feet. Required, MN .

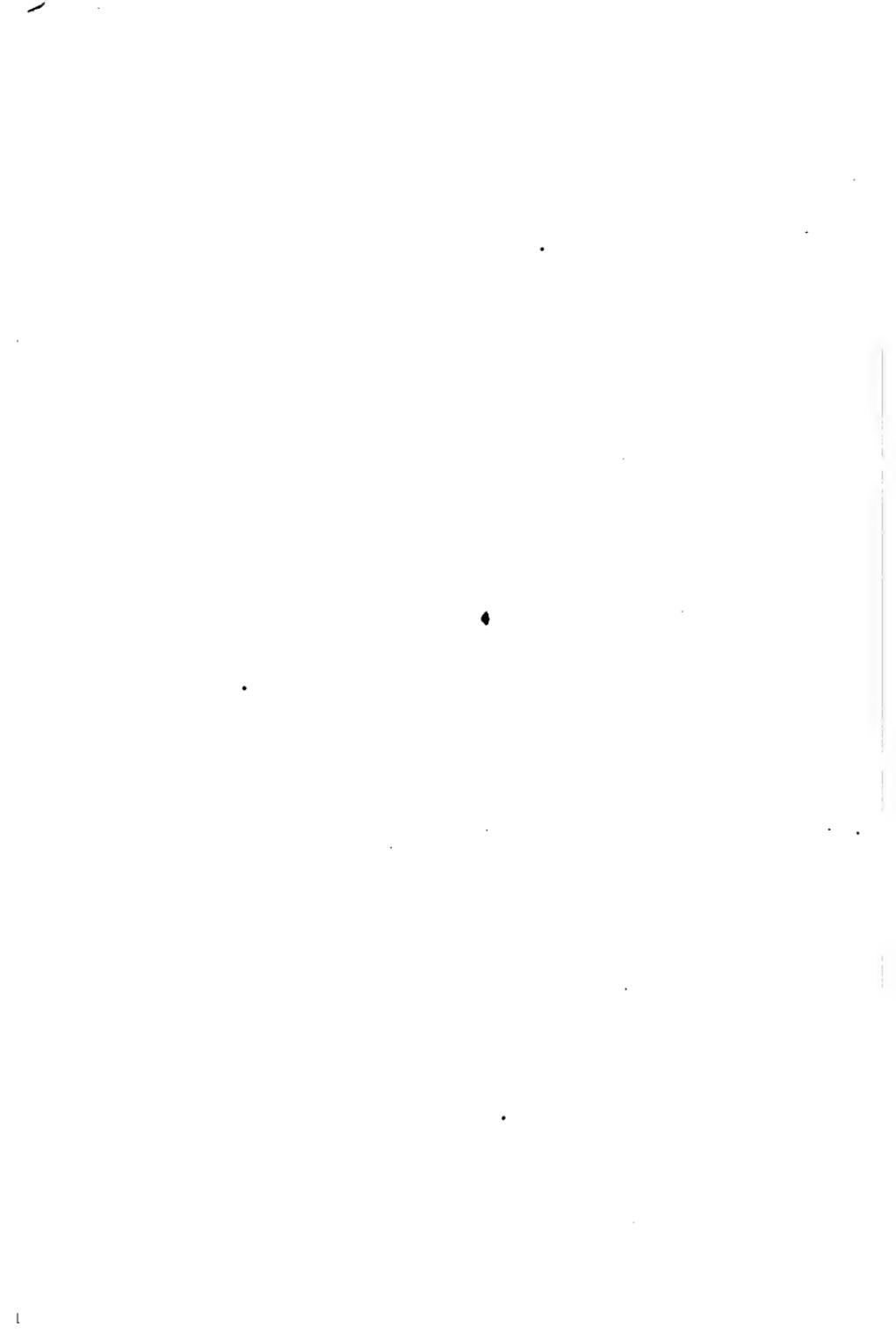
9. Wood-choppers, desiring to know the height of a tree before cutting it, sometimes make an isosceles right-angled triangle of wood or paper, and "step off" the distance on level ground from the point at which they find they can just see the top of the tree looking along the hypotenuse of the triangle, the base being parallel to the ground.

How high is the tree AB , if AC is 36 paces of 3 feet each, and the angle ACB is 45° ?



10. B is a point on the bank of a stream due east of A on the other bank. A boy walks due south of A until he reaches a point at which he finds, from his pocket compass, that he is directly southwest of B . If the distance AC measures 119 yards, how wide is the stream?





TABLES

LINEAR MEASURE

12 inches (in.)	= 1 foot	ft.
3 feet	= 1 yard	yd.
5½ yards, or 16½ feet	= 1 rod	rd.
40 rods	= 1 furlong	fur.
320 rods	= 1 mile	mi.

1 mi. = 320 rd. = 1760 yd. = 5280 ft. = 63,360 in.

A *hand*, used in measuring the height of horses, = 4 in. A *knot*, used in measuring distances at sea, = 1.15 mi. A *fathom*, used in measuring the depth of the sea, = 6 ft.

SQUARE MEASURE

144 square inches (sq. in.)	= 1 square foot	sq. ft.
9 square feet	= 1 square yard	sq. yd.
30½ sq. yd., or 272½ sq. ft.	= 1 square rod	sq. rd.
160 square rods	= 1 acre	A.
640 acres	= 1 square mile	sq. mi.

1 A. = 160 sq. rd. = 4840 sq. yd. = 43,560 sq. ft.

A *Section* of land is a square mile.

Roofing, flooring, and slating are often estimated by the *square*, which contains 100 square feet.

SURVEYORS' MEASURE

In measuring land, surveyors use a chain (ch.) which contains 100 links (l.) and is 4 rods long. Since the chain is 4 rods long, a square chain contains 16 sq. rd., and 10 sq. ch. = 160 sq. rd., or 1 acre.

CUBIC MEASURE

1728 cubic inches (cu. in.)	= 1 cubic foot	cu. ft.
27 cubic feet	= 1 cubic yard	cu. yd.
128 cubic feet	= 1 cord	cd.
16 cubic feet	= 1 cord ft.	cd. ft.
8 cord feet	= 1 cord	cd.

Note. — In computing the contents of an enclosing wall, masons and brick-layers regard it as one straight wall whose length is the distance around it on the outside. Corners are thus measured twice.

A *perch* of stone or masonry is 16½ ft. long, 1½ ft. thick, and 1 ft. high, and contains 24½ cu. ft.

YB 35889

MEASURES OF CAPACITY

LIQUID MEASURE			DRY MEASURE		
4 gills	= 1 pint	. . . pt.	2 pints	= 1 quart	. . . qt.
2 pints	= 1 quart.	. . . qt.	8 quarts	= 1 peck	. . . pk.
4 quarts	= 1 gallon	. . . gal.	4 pecks	= 1 bushel	. . . bu.

The standard *gallon* contains 231 cubic inches.

The standard *bushel* contains 2150.42 cubic inches.

The capacity of cisterns, reservoirs, etc., is often expressed in barrels (bbl.) of $31\frac{1}{2}$ gallons each, or in hogsheads (hhd.) of 63 gallons each. In commerce, these vary in size.

AVOIRDUPOIS WEIGHT

16 ounces (oz.)	= 1 pound	lb.
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2000 l				

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APOTHECARIES' WEIGHT

60 grains (gr.)	= 1 dram	. . . dr.	, or 3.
8 drams	= 1 ounce	. . . oz.	, or $\frac{3}{5}$.
12 ounces	= 1 pound	. . . lb.	, or fb.

One pound Apothecaries' weight = 5760 grains.

BRITISH OR STERLING MONEY

4 farthings	. . . . .	= 1 penny	. . . . .	d.
12 pence	. . . . .	= 1 shilling	. . . . .	s.
20 shillings	. . . . .	= 1 pound	. . . . .	£.
5 shillings	. . . . .	= 1 crown.		

The unit of money in United States gold coin, which is 19.3 cents. The unit of German money is the Pfennig, which is 1 cent.

